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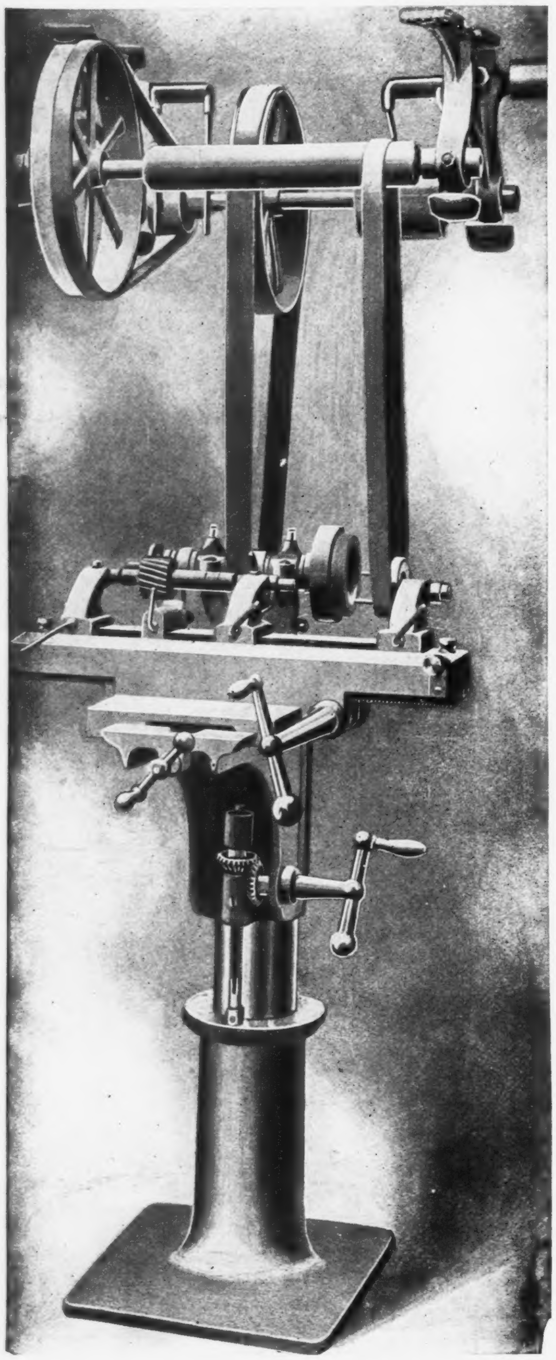

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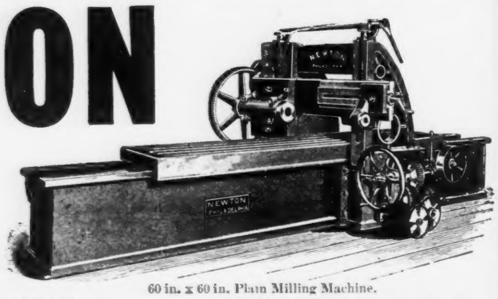

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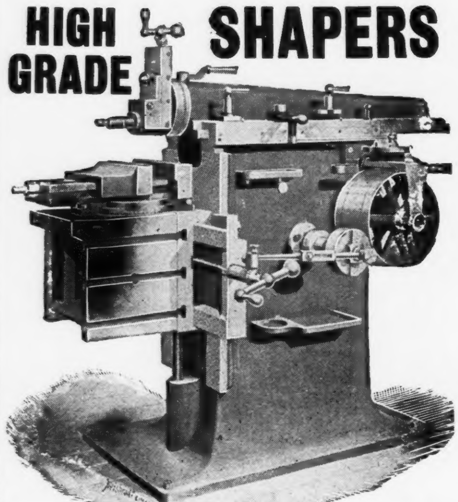

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MACHINERY.

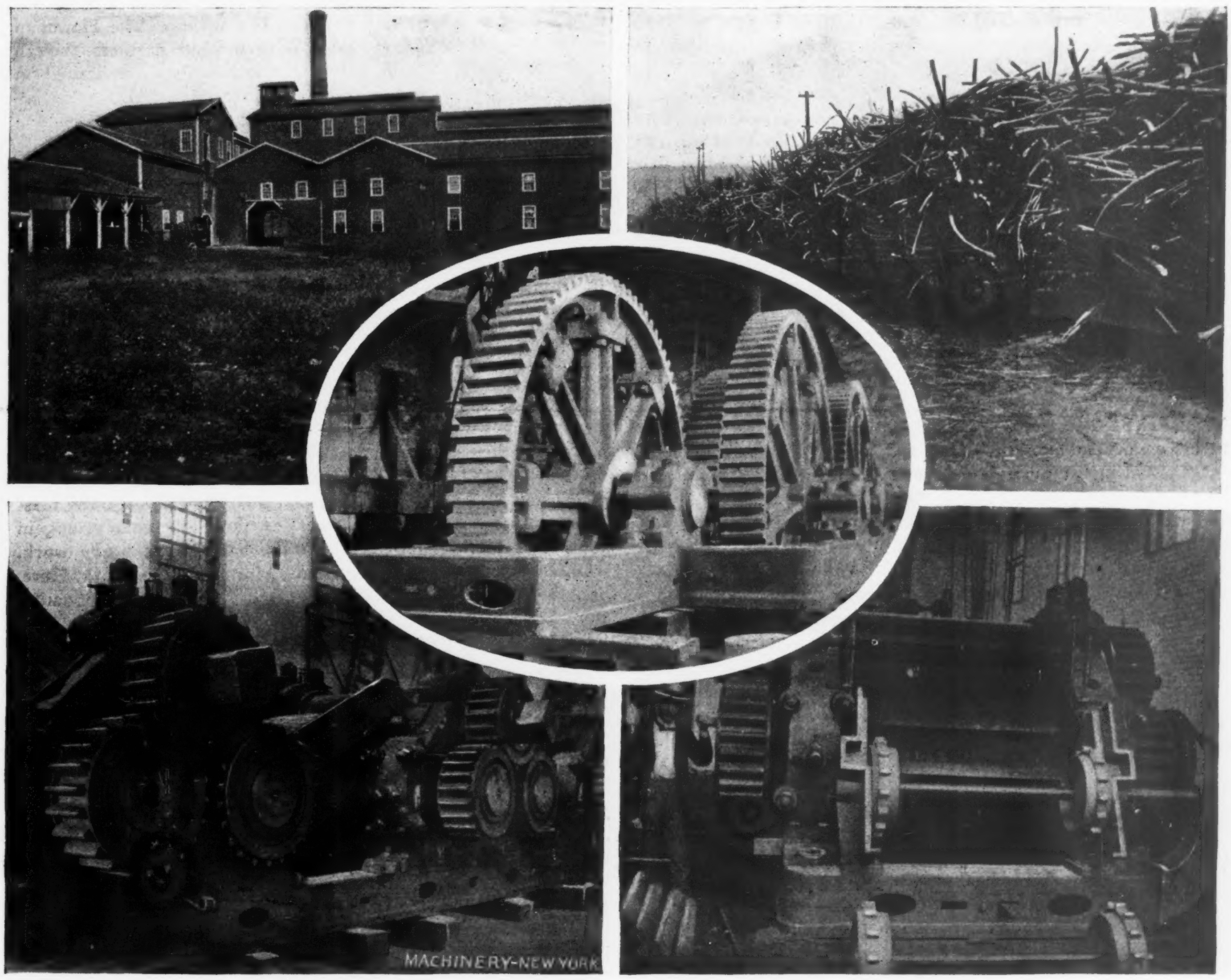
Vol. 5. September, 1898. No. 1.

FROM THE HAWAIIAN ISLANDS, U. S. A.

A DESCRIPTION OF THE HONOLULU IRON WORKS, THE LEADING SHOPS OF OUR NEW COLONY—AN ESTIMATE OF THE NATIVE MECHANICS—THE CLASS OF MACHINERY BUILT.

ALFRED DUNN.

AS all Americans are interested more or less in the Hawaiian Islands, it is in order to describe its manufactures in the line of machinery and the shop where such is manufactured. The Honolulu Iron Works is the principal, and with the exception of two smaller shops, the only machine shop on



SUGAR MILL, EWA PLANTATION. GEARING BED; NINE-ROLLER MILL. TRAIN LOAD OF CANE READY FOR GRINDING.
NINE-ROLLER CANE MILL, SIDE VIEW. NINE-ROLLER CANE MILL, DISCHARGE SIDE.

VIEWS FROM AN HAWAIIAN SUGAR MILL.

the whole group of islands. These shops are located in Honolulu, Island of Oahu, and form almost a full square, bounded by Queen, Nuuanu, King and Maunakea streets. The Queen street side is close to the wharves, thus making it very convenient for shipping machinery, as almost all the machinery manufactured goes to the other islands, there being at present only six or seven plantations on Oahu, out of a total of forty-five or fifty plantations.

These shops were established in a small way over thirty years ago, and have grown gradually to their present proportions. Due to this, the arrangement of the shops is not what would be considered a good and economical arrangement at the present time. They manufacture complete equipment for the production of unrefined sugar, including sugar mills, mill gearing, triple and quadruple effects, vacuum pans, sugar coolers, clarifiers, superheaters, mud presses, cooler cars, syrup tanks, cane cars; also steam boilers, both land and marine, and of all sizes.

They also make steel riveted pipe of any diameter and length, for conveying water from the pumps for irrigating purposes in the cane fields.

Besides the above regular work they do a large repair business among the steamers that call at the islands and the fleet of steamers used in the freight and passenger business between the various islands. They also transact a large business in steel plate, bar iron, wrought iron piping up to 12 inches diameter, valves, fittings, etc.

The establishment consists of an office, machine shop, pattern shop, foundry, blacksmith shop and boiler shop, together with the necessary pattern and other storage houses required. The office is a substantial two-story building, about 30 feet x 35 feet, built of coral rock and plastered outside. The lower story is used as a general office and occupied by the secretary, book-keeper and timekeeper. The manager occupies a small office built adjoining the main office. The above officers and an office boy constitute the clerical force employed, which is the smallest force the writer has seen in any shop which transacts the amount of business that is transacted here.

The drawing office is located in the second story of the office building, and while small, is well lighted and conveniently arranged, as will be seen by referring to picture. On either side of the room are arranged the cases containing the drawings. The tracings are filed flat in paper portfolios, which are inscribed on the outside with the contents, and which also has a letter indicating the portfolio and the drawer number, as 34 x 78 Mills, Drawer No. 2 I, the I representing the particular portfolio in Drawer 2 in which the specified size of mill is kept. Each tracing is marked with the drawer number and portfolio, so that it can be easily filed. On the outside of each drawer is an index, giving the full contents of each drawer. The standard size of tracings used are 15 x 20, and 20 x 30 and 30 x 40, the two smaller sizes being used for detail work. We manufacture our own blue paper, as prepared paper will not keep for more than two or three days in this climate. The drawing office force consists of four men, besides the chief draftsman, which is sufficient for all ordinary run of work. They are all Americans except one, who is part Hawaiian and Tahitian. Adjoining the main office is a storage room for supplies such as valves, fittings, etc. etc.

On account of being so far from a base of supplies, and having no telegraphic communication with any other country, a large stock has always to be carried, not only of pipes and fittings, etc., but also mill shaft forgings, boiler plate, steel pinions and gear segments, copper and brass tubes, pig iron, coal, coke, copper, babbitt, etc., amounting to thousands of dollars. While some of this material comes from the States, the pig iron, coke and boiler plate are imported from England, being cheaper, notwithstanding the long distance it is transported, while the coal comes from Australia. The greater part of the material obtained from the States is purchased through brokers in San Francisco and New York.

Adjoining the storage room is the erecting shop for heavy machinery. This consists of a brick building 53 feet x 53 feet, in the center of which is located a jib crane, 8 tons capacity, for handling the machinery. Adjoining this building is another building, 26 feet x 53 feet x 41 feet high, which is used for erecting vacuum pans, quadruple effects and other work requiring a great amount of head room. A 12-ton traveling crane handles the work erected here.

To the right of this building is the one containing the machine tools, and is 34 feet x 61 feet, with an L 36 x 72 feet. The equipment consists of six small lathes, two by Geo. W. Fifield, Lowell, Mass., one by F. E. Reed, Worcester, and one by Putnam Machine Co.; two shapers, by Hendy Machine Co., three drill presses of English manufacture; one milling machine, by Pedrick & Ayer; one horizontal boring mill, by Newark Machine Tool Works; one 8-foot boring mill, by Bement & Son; two 30-inch x 11-feet and two 48-inch x 22-feet lathes of English manufacture; one Pond lathe, 60-inch x 15-feet; one Pond radial drill; three planers and two large slotters of English manufacture. There are also two Watson & Stillman hydraulic jacks, one 350 tons and one 65 tons capacity; a pit lathe, with face plate to swing 12 feet, by Risdon Iron Works; two large pipe threading machines to accommodate 10-inch pipe, by D. Saunders & Sons, Yonkers, N. Y.; two bolt cutters, one Acme Machine Co., one Wiley & Russell, and a large side planer, by the San Francisco Tool Co., to take in about 5 feet 6 inches x 17 feet.

All keyseating of large work is done upon the planer, the work being clamped to a face plate. A portable keyseater could be used very profitably, as also a large open side planer, the latter for planing mill cheeks and beds, which are too large for an ordinary planer. The rolls for the cane mills require a great deal of care in their manufacture. A good close iron is required, so that the cane juice will not be forced through the pores into the center of the roll, due to the great pressure under which the rolls are operated (400 tons).

These rolls are cast on end, to insure a good, clean and sound casting the full length of the roll. They are bored out in a horizontal position with a boring bar, and after being keyseated, are forced upon the shaft with a pressure ranging from 100 to 200 tons. They are then keyed solidly in position, but in spite of all the care used, the juice finds its way into the inside of the roll, and attacks the iron next to the shaft, often causing the roll to work loose on the shaft. When old shafts have been removed from rolls, a gallon or more of juice has been taken from the inside of rolls. The rolls range from 30 inches to 34 inches in diameter, and from 60 inches to 78 inches long, and when complete, with shaft weigh from six to eight tons each.

A number of the skilled mechanics are native Hawaiians, or part native, who have learned their trade in this shop, while the rest are whites. At a dinner given the employees by the owners some weeks ago, a former superintendent in a speech made the remark that a Hawaiian planer hand there employed need not take a back seat for any white man in the shop. The Hawaiian mechanics can do as good a job as their white partners, though their knowledge of shop methods is necessarily more limited on account of having worked only in the one shop. All the helpers employed are Hawaiians, and are stout, lusty fellows, and very willing to work. The general impression seems to prevail in the States, among the people who have never been here, that the Hawaiians are ignorant and half savage, but such is very far from being the case.

The tool room is situated in a building outside of but near to the machine shop. It is fairly well equipped with tools, but one thing is lacking which is very essential in a shop, and that is a system of standard gauges. All rolls and other work which is to be interchangeable are made to rod gauges. For ordinary work the exactness of the sizes depends on the good judgment of the mechanic who does the job.

Adjoining the machine shop is the blacksmith shop, 50 feet x 75 feet, and is well equipped for the class of work done. A large steam hammer, capable of drawing down a 12-foot shaft, is used for all work which cannot be forged by hand. A bolt header is also installed. Five fires are kept going continually, the blast being supplied by a Root blower. A large jib crane swung in the center of the shop facilitates the handling of heavy work, while numerous small cranes are used for the lighter work. Here, as in the other shops, the employees are divided in nationality, the foreman and one smith being white, while the rest are Hawaiians.

The pattern shop is large and well lighted, and about 60 feet x 100 feet, and well equipped with modern wood working tools. The lower part of the building is used as a carpenter shop. The carpenters are all Hawaiians. Adjoining the pattern shop is the foundry, built of brick and about 60 feet x 100 feet in size. Two large jib cranes are used for handling molds, etc. Two 36-inch cupolas supply all the iron used, the average melt being 25 tons per week. Blast is supplied by a Root blower. All sizes and kinds of castings are made, ranging from a mill cheek, weighing several tons, to a stove lid, weighing two or three pounds.

A small brass foundry adjoins the main foundry, where castings weighing up to 700 pounds are made. The workmen comprise both whites and natives, the whites doing the better class of work and the natives the rougher. All castings, both large and small, are cleaned by hand, that useful machine, a rumbling mill, not having been introduced as yet. To the north of the machine shop is a boiler shop, which is large and well equipped. A large steam riveter does all riveting on boiler shells and other heavy work, while a small hydraulic riveter is used for pipes. There is also a large plate planer, two plate bending machines, a large combined punch and shear, besides several smaller punches.

All flanging of boiler heads is done by hand, while caulking is

done by means of compressed air. There are at present under construction ten boilers of different sizes, and about 20,000 feet of 30-inch steel piping.

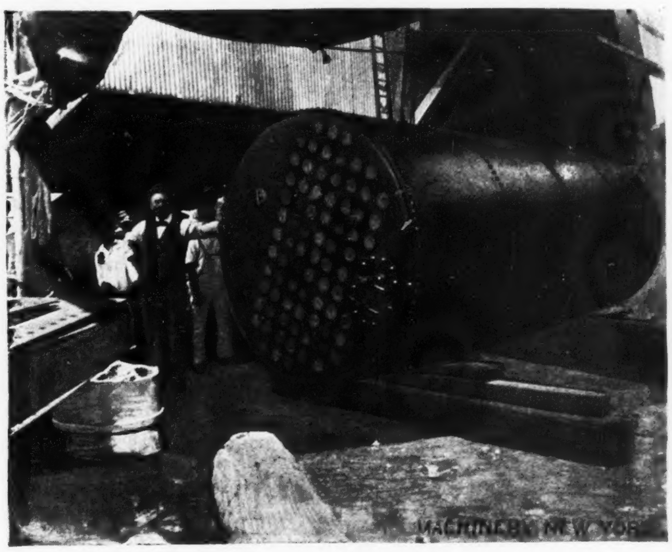
is conducted, which is not the most economical arrangement, but probably the best considering the arrangement of the shops. One good feature here is that strikes are practically

FRONT OF SHOPS, FACING WHARF.

FOUNDRY.

DRAFTING ROOM.

PATTERN SHOP—NATIVE MECHANICS.



SIX-FOOT TUBULAR BOILER READY FOR SHIPMENT.

FOUNDRY AND PART OF MACHINE SHOP.

VIEWS FROM THE HONOLULU IRON WORKS.

The steam plant for the establishment consists of a Lancashire boiler 6 feet diameter x 20 feet, fitted with Galloway tubes, and is located about central among the various departments. Each department is driven by a separate engine, to which the steam

unknown, as we have no trades unions, etc., to cause same. The workmen are well paid, the average being as follows: Patternmakers, \$3 to \$3.50; machinists, \$4; boilermakers, \$4.50; molders, \$3 to \$4; blacksmiths, \$2.50 to \$5, depending on the ability of the

workman. The regular work hours are 7 to 12, and 1 to 5, being nine hours daily, except on Saturday, when the work ceases at 4 o'clock, but the workmen are paid for nine hours as on other days. Time and a half is paid for overtime. The pay roll is made up to and including the Friday preceding pay day, which is every other Saturday.

The workman is given a perforated slip with time and amount due on same, one part of which he signs and deposits in a box used for the purpose, and which slips are kept by the company the workman keeping the other part. The total number of men on pay roll is from 200 to 250.

Some of the latest productions of the shops are an 8-foot quadruple effect, and weighing, when completed, about 200 tons, and a 32-inch x 60-inch 9-roller cane mill complete, with gearing bed and engine weighing about 150 tons.

We have at present orders in hand for one 34-inch x 78-inch 9-roller cane mill, which, when completed, will weigh about 200 tons; one 34-inch x 72-inch 9-roller cane mill and one 32-inch x 60-inch 9-roller cane mill, besides a great amount of smaller work.

While conditions seem so favorable to the workman the writer would not advise any one to come here, as a limited number of men only can be employed, and when a man is once laid off, there is no other place where he can get employment in that line of work.

* * *

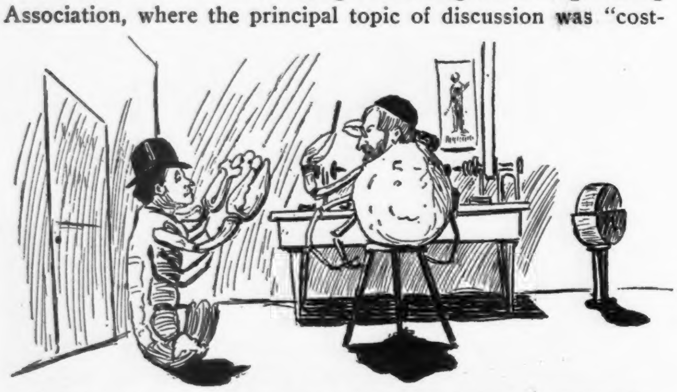
The "American Electrician" gleans the following receipt for machine shop and engine room floors from a German contemporary: Portland cement, 1 part; unslaked lime, ½ part; sand, 3 parts, and sifted clinkers, free from ashes, from 7 to 8 parts. For a top dressing of finer mass the composition should be 1 part cement, 3 parts sand and 2 parts of finely ground and sifted clinkers, the dressing to be well rammed and rolled after laying. Floors constructed in this way are said to be practically indestructible.

* * *

DOINGS OF THE SHELLFISH CLUB.

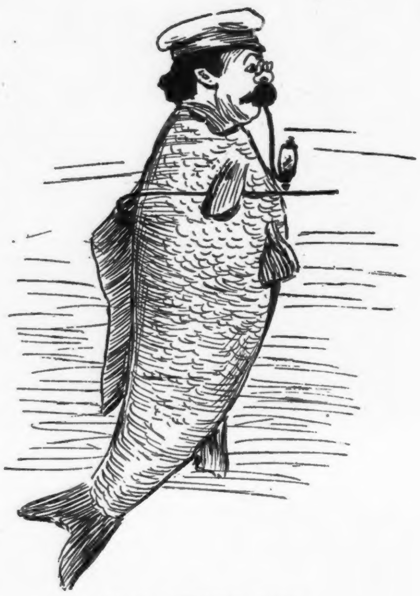
A TRUE FABLE, BY THE CRAB.

The Crab was in a quandary; he had been running his bakery for years, had made quite a nice little sum of money out of it and thought he was the only one on the beach, but he had just returned from the annual meeting of the Anglo-fish Engineering Association, where the principal topic of discussion was "cost-



"CRAB, DON'T SWALLOW ALL YOU HEAR ABOUT SUCH THINGS."

keeping," and had listened in rapture to the finely worded paper presented by Prof. Gold-fish, who proved quite conclusively that the only way to get an accurate cost of machines built was to add 10 per cent. to material, plus labor, plus 25 per cent., plus 10 per cent. for expenses, then double it for a selling price, which could be governed by x. Then Mr. C. O. D. Fish gave an elaborate tale of how he ran things in his plant, whereby not a single scale could fall off a fish without it being accounted for and charged to the job by an automatic check system they had. His arguments carried some weight with them, because he had made several voyages to the South Sea Islands for his health, and had been around the world quite a bit. Prof. German Carp had also submitted a well-executed diagram, showing that as a c over b equaled x, so did aa cc over bb equal double x, and by his diagram one could tell just what it cost every time to build any old machine, and then they went out to lunch and said a whole lot of nice things, and the Crab came home fully convinced that he must have a cost account or bust up. But he wondered how to begin it, what it would cost to have a cost account, and which one of the many ways he had heard praised as the only way was the best one for him. While all this was going through his mind the Lobster dropped in to get a reamer ground, as his grinder was out of fix, and the Crab told his troubles. The Lobster carefully wiped his spectacles and said: "Crab, don't swallow all you hear about such things, but look up the antecedents of the fellow who talks. Now, Prof. Goldfish never worked a shop for all he is worth in his life, but spends most of his time explaining to the boys in his school how they can make a lathe or planer work and make chips without any regard to the value of earning a dollar. Old C. O. D. Fish has been president of a corporation for the past ten years, and been living on terrapin at the big hotels, and when he does go through his works, it is done so rapidly that he really doesn't know it, and he really has'nt been in close touch with the details of his plant for years; but he talks well; and as for German Carp, he never worked in a shop and earned a dollar in his life, to say nothing of his contact with cost accounts. Successful cost accountants are not bothering with diagrams and a b c and x. Life is too short, and they have to hustle around and get a divvy for the boss. Now, if you want a cost system, take one of your brightest apprentices, just out of his time, and send him for six months to a business college up in the city. Then turn him loose in the shop, advise him what to do, don't forget to pay him what he is worth, and last of all things, don't try to establish a 'selling price,' but just keep on trying to whittle down



PROF. GERMAN CARP.

PROF. GOLDFISH

your costs below the competition I am setting before you on my machines. Just see how much money you can make on your machines at the prices you are compelled to get for them, and if you don't make enough to pay you, just stop making them. That is what your cost clerk is for." I have heard that the Crab has since knocked several barnacles out of his catalogue, on which his cost clerk found there was no profit, and that he has met some sharp competition on others by shading his prices a little, and it is rumored on the beach that he is making money still.

THE OIL ENGINE.

W. H. Booth.

America ought to be particularly the home of the oil engine. Common as is becoming the use of electricity for both power and lighting purposes, there are still many places in so wide and sparsely populated a country where power is not available except in the form of some heat engine. Steam is unsuitable and gas is perhaps not available, whereas oil is everywhere. In the course of my experience, even in England the oil engine has frequently presented itself as the best motive power to be employed in outlying parts of the country. Indeed, old as the country is, there are places within a couple of hours' journey of the greatest city on earth which are in a sense as remote from modern civilization, as we term our high pressure way of life, as they were in the times of Queen Elizabeth, over 300 years ago.

But even in these places an odd man or two wants to have the electric light or he wants to pump water from a bore hole instead of from a pit near the farmyard, and for such men the oil engine has been found most convenient. It is customary to speak of the oil and gas engines as being practically alike. There is one very notable difference. The gas engine stops if overloaded. The oil engine is very apt to stop if under-loaded. The reason of this is curious and applies to one special type of engine—that type which has no external ignition to itself, neither by electricity nor otherwise, but ignites by means of a heated chamber, which is kept to ignition temperature by the repeated explosions of the charges. In this class of oil engine the oil—Russian oil is a good deal used in England—is injected by a small pump into the vaporizer. The Otto cycle is worked and ignition occurs when the mixed charge of air and vapor becomes compressed in the hot vaporizer, the temperature of which is kept up to redness. In starting these engines the vaporizer is first heated by a lamp blown by a fan or by a retort lamp blown by its own self-generated oil gas, like a lucifer or Wells light. After being once heated the vaporizer is kept hot by the recurring explosions. If, however, an engine is underloaded many of the explosive strokes are of course cut out, as in the case of the gas engine. The vaporizer does not receive so much heat and finally cools below the temperature of ignition and the engine stops. There are so many small duties to be performed by oil engines that the difficulty is to find an engine small enough. Engines of 1½ and 2½ horse-power as listed in makers' lists are much too large for many men's requirements. Even with a deep well, with water level about 140 feet below surface, and a tank 80 feet above surface, I have found that an institution containing a population of perhaps 200 could, without stint of water, be worked by a 2½ horse-power oil engine, and there was trouble for a long time because the engine would not keep hot. When once the difficulty was overcome it worked perfectly and would run hours at a time locked away in a house by itself with the pump.

When speaking of oil engines I do not refer to those using the highly inflammable petroleum spirit known as "petrol" in France, but to those which use ordinary safe lamp oils. The benzine engines are like gas engines—there is no need for vaporizers. But Daylight oil and Russoline must be vaporized by heat. At the back of the cylinder is a bottle-necked vessel, in which explosion occurs. This vessel receives the oil jet and this oil vaporizes during the forward movement of the piston, which draws the air charge into the cylinder. The vaporizer contains no air. As the piston returns it forces the air through the bottle neck, and gradually there is formed an explosion mixture in the vaporizer. The proportions and compression are so arranged that explosion occurs just at the point of extreme compression. It is well known that explosive mixtures will ignite when compressed against metal surfaces at a comparatively low temperature. Explosion may sometimes fail to occur. This may be due to one of three reasons. The vaporizer may be too cold or there may be an insufficient volume of air forced into the vaporizer or the compression may be too limited. The latter, as well as the second cause are both remediable by the addition of extra compression plates to the back of the piston. These cause a higher pressure and also push more air into the vaporizer and explosion is effected, but otherwise would not be. The use of the safe lamp oils in engines has been perfected better in Great Britain than either in America or on the Continent of Europe. The reason of this is partly because the regulations as to the storing and use of the more inflammable oils are much more stringent in Britain than elsewhere, or have been so until recently, when some relief has been made for the benefit of the motor car industry, or so much of it as has not been swept away by the unscrupulous contact of unprincipled company promoters. The engines used in these motor cars are not oil engines proper. The liquid they use is so very volatile that it will mix with air drawn over it and form an explosive mixture very readily. Owing to the great absorption of heat which occurs when a liquid evaporates, the heat becoming latent in the vapor, the body of liquid in the container is rendered very cold, and its tendency to vaporize is unduly checked. This tendency can be checked and heat added by circulating some of the cylinder exhaust or of the water of the cooling jacket round the container, and this is what is done in the benzine cars. Petroleum cars, or those which use lamp oil, are much safer than benzine cars, but, bad as some people consider is the smell of the exhaust from a benzine motor, that of a petroleum motor is worse. It is difficult to secure perfect combustion in an oil engine, and a considerable quantity of half-consumed vapor escapes with the exhaust. The perfecting of combustion is the chief difficulty to be overcome and offers a field for the inventor. Motor cars have not yet appeared in overwhelming numbers. A day rarely passes without seeing one apart from the electrical cabs, which are to be seen everywhere. If an electric cab be chartered for a journey not approved by the driver he will run a short distance, then stop and declare the machine has gone wrong, so getting rid of his unwelcome fare. This sort of thing is going to do harm to the electric cab. However, to resume. There is a strong feeling in some directions, which is voiced by the "Engineer" journal, that the road motor car, when it is established, will be a steam car, and the fuel will be oil. There is no difficulty in securing perfect combustion of oil for steam boiler firing. This preference for steam arises from the greater elasticity of the steam engine. If an average horse power of 3 will run a car on a level and 12 horse-power is required for grades an oil car must have a 12 horse-power motor on board, because an oil engine cannot work at a higher rate than that of maximum economy, which is that of an explosion every second revolution. But a steam engine works at its economical rate of, say, four expansions, and is more powerful for its size than an oil engine. For a short run up a hill steam can be got up high and the engine run wastefully in full gear for a few minutes at very much more power than that of its maximum economy. To secure the same power from an oil engine we should require always to carry a much bigger engine and to run it at fewer explosions when on the level, and except on the steep gradients we should be wasting fuel all the time with an underloaded engine. We are able, in fact, with a steam engine to carry initial pressure all the length of the stroke, but with the oil engine the cut-off is fixed early and unalterably. These facts have a very great and important bearing on the question of motive power for road vehicles, so much so that the "Engineer's" quoted dictum as to steam being the one available power, must be confessed to be well grounded. It is, moreover, exceedingly difficult to consider that the oil engine can be so modified as to secure the advantages claimed for and possessed by steam. The only method in sight is that of continuous combustion of oil and the storage of the product at pressure in a reservoir from which the engine shall draw. No one who has not thought over and schemed on this can realize the difficulty of the problem, which does not seem to present much prospect of economy because, wasteful as is the water jacket, the present arrangements for internal combustion engines enable a rapid expansion to get some benefit from high initial temperature, and it is doubtful how the product of burned gas could be safely stored at an economically high temperature. Apart from this method of storing energy there is the method of compressed air. By means of a small air compressor on the motor air would be stored in a receiver at high pressure, and for hill climbing the engines would be run by this air. But what about long hills? The prospects are not encouraging. There is, of course, always the alternative speed method, by which the smallest motor practicable on the level can be geared down to creep its car up the steepest of hills. But hill creeping is not exhilarating. The horse is like the steam engine, and can exert, for a short time, several horse power in surmounting obstacles, and no motor that fails to imitate the horse will find the pathway to success very easy.

24-INCH LATHE WITH SHAFTING ATTACHMENT.

The Springfield Machine Tool Co., of Springfield, O., have recently designed attachments that can be supplied with their regular 24-inch lathe, if desired, whereby the latter can readily be converted into an efficient shafting lathe. The attachments in no way detract from the utility of the lathe for regular lathe work.

Fig. 1 is a general view of the lathe, as arranged for shafting turning, and Fig. 2 shows the details of the arrangement for transmitting power from the headstock to the tailstock.

The shafting rest is placed on the carriage in place of the regular compound rest, and three tool posts are used, two to the left and one to the right of the follow rest, and all at the front of the carriage where they are easily accessible for adjustment. The

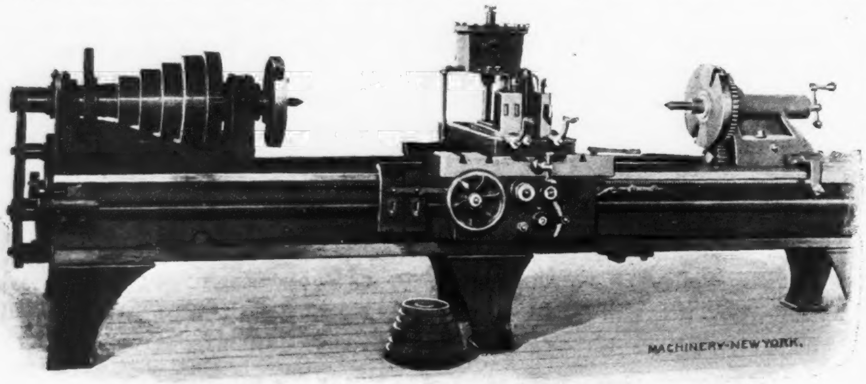


FIG. 1. SPRINGFIELD SHAFTING LATHE.

shafting rest is designed to be provided with split cast iron collars for each size of shaft to be turned, this method being adopted because such collars are inexpensive, and present a large surface for wear.

The tailstock drive receives its power from the face plate gear, and as this drive is required only a small part of the time, a tumbler gear, *T*, is used for throwing the drive either in or out of gear. The tumbler gear is pinioned on a lever, *L*, having a worm wheel segment at its lower end at *W*, which can be moved by hand one way or the other by means of the worm shown in section at *W*. An unusually large wearing surface is allowed for the face gear and face plate on the tailstock, and the tailstock spindle is clamped in a substantial manner through the medium of the worm and the worm gear, which can be seen in the sectional view of the tailstock. The worm gear is threaded onto a split taper sleeve, and any rotation of the gear draws in the sleeve and tightens it upon the spindle.

A copious supply of lubricant for the cutting tools is one of the requisites for shafting turning. To meet this requirement, there is a reservoir at the back of the carriage, not visible in either view, from which a duplex, single-acting pump draws its supply, and forces the lubricant to the tank, appearing just above the shafting rest, from which it is fed to the tools. This tank has an automatic relief valve, which can be adjusted so that the various pressures may be maintained. When the lathe is started, it is unnecessary to give the pump any attention, as the relief valve provides for an overflow.

To convert the lathe again into one for regular work, it is only necessary to remove the shafting rest, replace the compound rest and disconnect the drive under the headstock by throwing out the tumbler gear. The machine is capable of handling shafts up to 5 inches in diameter and 30 feet long.

* * *

MAY BE HEARD FROM LATER.

I recently visited a bobbin mill which was the only industrial establishment in a small country town. It was situated in a lumbering region, where the lumber could be had without heavy bills for haulage, and although it was situated a dozen miles from the railroad, the expense of shipping the finished bobbins would not, of course, be a very heavy item. The plant was operated by portable engines with boilers of the locomotive type, and these boilers were all there was of interest about the place from a mechanical standpoint. There were three of them in all, one being in the yard for operating a large cross-cut saw, while the others were set up in the mill. In passing the yard boiler I noticed a piece of rope tied to the safety valve lever. There were no extra weights hung to the lever, but the rope looked suspicious. I hastened on, and upon entering the engine room thought I had made a "find" in the line of boiler design. It is well known that a sphere is stronger than a cylinder of the same diameter and the manufacturer of these boilers had evidently acted upon this principle and built two boilers, consisting of four plates rolled into the form of spheres and riveted together, something after the Harrison water-tube boiler style. My first impulse was to hunt for the name plate to see who had been enterprising enough to adopt this improved method. Remembering the ropes on the safety valve lever in the yard, however, my second impulse was to run. These valves were probably overloaded, the plates were bulging and I pictured both boilers going up at the same time and I along with them. At any rate, each plate was bulged out nicely and uniformly half the way around, between each circumferential seam, presenting the appearance mentioned above, and the engine room did not seem exactly like a safe place to stay in.

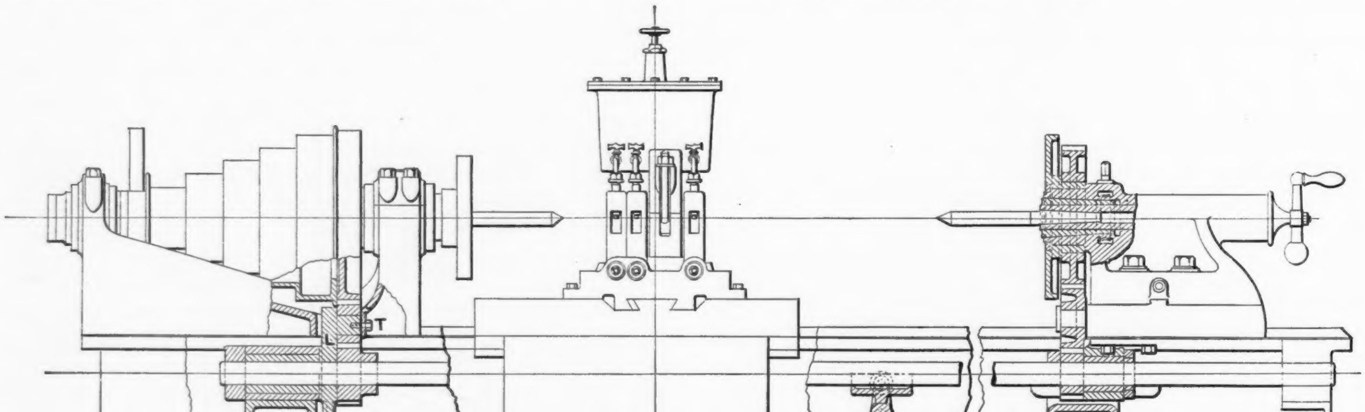


FIG. 2. DETAIL OF TAILSTOCK DRIVE.

That night at the store the engineer told me the particulars about the steam plant. The boiler in the yard was an "all-fired good one," he said. He had often run her with "pokers and things fastened to the lever," but he knew she would stand it, because he "tested her once up to 160 pounds hydraulic pressure, until some of the tubes bent in and had to be replaced. She is stayed to beat all creation, and you couldn't blow her up." Regarding the boilers in the mill, he said that there had been a fire the year before, that the timbers tumbled over the boilers, and heated things pretty hot, and that the bulging took place then. "But the boilers are mighty good steamers, and I

don't have any fear but they are all right for all the pressure that we want to carry."

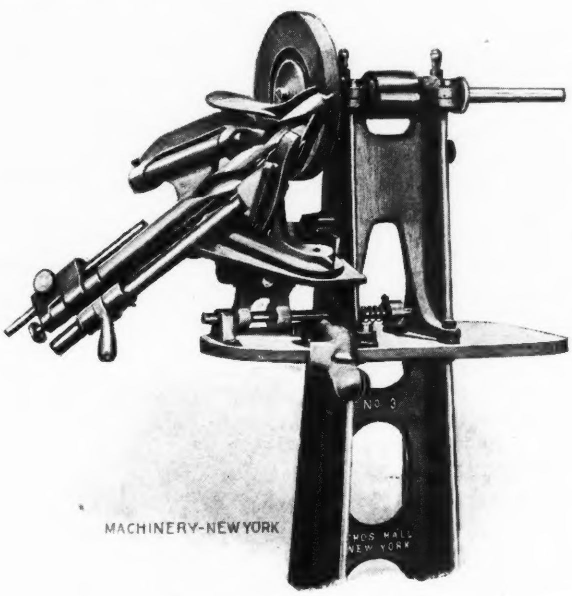
There is no moral to what I have written. The time has gone by when morals can be drawn from recklessness in caring for steam boilers. People won't take the lesson. This is simply a recital of actual fact, and I wonder when the time will come for one of these boilers to give way, and whether my engineer friend will be one of those to suffer thereby.

OLIN SNOW.

* * *

THE "IDEAL" TWIST DRILL GRINDER.

The twist drill grinder illustrated herewith is made in three sizes, the smallest of which will grind drills from No. 70 to ½ inch in diameter, and the largest will take drills up to 3 inches in diameter. The essential feature of this grinder is that the drill is held automatically at the point by two steel fingers which fit into the grooves, the other end of the drill being at the same time supported by a center. The fingers and the center are attached to a pivoted arm, the axis of which is so placed, that by giving the arm a slight movement and thus moving the drill across the face of the emery wheel, the lips of the drill will be ground at the correct angle, and with enough clearance to insure a good cutting edge.



TWIST DRILL GRINDER.

This arrangement makes it possible to hold a drill correctly and firmly, even though it be of the smallest size, and when it is once clamped in position, the operator has simply to oscillate the drill and holder on its pivot, as previously described. The machine shown in the illustration will grind drills up to 1½ inches in diameter, and is provided with a base, or made in the bench style, as desired. The base is designed to include the countershaft, which makes a very compact arrangement.

These grinders are manufactured and sold by Thos. Hall, 853 Broadway, New York.

* * *

AT PRATT INSTITUTE.

The Director of the Department of Science and Technology of Pratt Institute, Brooklyn, N. Y., calls attention to the work that is being done in the two-year courses in drawing and machine design and applied electricity. These courses are not intended to train expert engineers or specialists, as are the courses in the best engineering schools, in which the work is necessarily theoretical, and involves so much higher mathematics that it is necessary to spend a great deal of time preparatory to taking up any of the technical work. The intention is, rather, to start with lower requirements for admission to simplify the work, so as to require no mathematics higher than plain trigonometry, and then devote the time as far as possible to practical subjects. We believe that a course of this nature will meet the requirements of many who cannot take a full college course, and we are glad to bring it to the attention of our readers.

A TALK ON BRASS FOUNDING.*

Brass founding, like most other trades, naturally divides itself into classes. One foundry makes a specialty of plumbing goods, another of chandelier fittings, while another will devote itself to making machinery castings generally.

Plumbing goods comprise, as the name signifies, all brass goods used by plumbers, such as faucets, waste cocks, ferrules, etc.

Yellow brass is the metal generally used, and the work is of such a character that the patterns can be carded, namely, attached to match plates or boards, or else "gated," that is, a sufficient number of patterns to fill the standard size of flask, are riveted or soldered to the gate, practically forming one pattern. Both "plate work" and "gate work" have their own individual spheres of usefulness, but the writer believes, from his own experience, that it is better to put the patterns on plates in preference to gating them, whenever it is possible to do so. Bibs and cocks with their component parts, such as plugs, handles, stems, etc., and globe and other valves, the parting lines of which are straight can be all made by the match plate system, thereby saving the time that would be expended in making matches, trimming the joint of the mold, etc., as is necessary with gated patterns.

In order to turn out this class of work to the best advantage, first-class flasks should be provided and kept in good condition. Interchangeable flasks are almost a necessity on plate work, as the plate must fit on the pin halves of flasks, which are used as nowels.

There is quite a knack in pouring, as the metal must be thrown into the mold with force enough to run, and at the same time not strain the casting.

Some alloys, as for example, phosphor bronze, require the mold to be rammed more than ordinarily firm, while in the case of aluminum bronze we must go to the other extreme and ram it exceedingly soft, so that the mold will not resist the excessive contraction, otherwise the casting will be drawn apart.

Phosphor bronze shrinks but little, but if poured too hot it will eat into a green sand mold almost like water; to prevent this it is poured cool into such molds. It can, however, be poured hot, provided the mold is well coated with plumbago, and then baked before casting.

Chain guards for ladies' bicycles are a class of work that sometimes cause a great deal of trouble. They are made of aluminum, and the trouble is caused by their cracking. After repeated trials, one firm, with which the writer is acquainted, made them successfully by soft ramming, gating them with two broad, thin gates on the sprocket wheel end, and elevating the sprue end six inches.

The metal was thrown in at a dark-red temperature, and immediately the copes were thrown off, while the metal in the sprues was yet liquid.

On small, loose jobbing work, when there is more than a dozen pieces required, it will pay to make "set" gates, as they save the time consumed in cutting and slicking the gates, besides producing cleaner castings. They are easily made as follows: Make a mold, cut the gate as required, leave the patterns in, close the cope and pour into the gate cavity tin at a low temperature, so as not to injure the patterns if they are wood. Should there be any castings previously made from these patterns, draw the patterns and substitute the castings, before closing and pouring the mold.

In making heavy brass work it is advisable whenever the shape of the pattern will permit, to pour from the bottom exclusively. Take, for instance, a brass bushing weighing, say, over 500 pounds. Suppose the pattern is 18 inches in depth, three or four feet in diameter and anywhere from 1½ to 2 inches in thickness and has a green sand core in the center. The casting had better be poured with two pots, and gate at the bottom through runner cores. When the metal will impinge on the green sand core, a piece of dry core is built in to prevent scabbing. The runner which leads the metal from the joint to the bottom of the mold should be about one inch in diameter. From the joint up, through the cope, it is enlarged to between two and three inches in diameter, thus we get metal to feed, and keep the gate solid. A so-called skim gate is used in pouring.

* From a paper read by Chas. Vickers, before the American Foundrymen's Association.

About four inches distant from the aforesaid runner with its riser another runner cuts through the cope, to the joint; it is connected to the riser of the first runner by a horizontal channel cut in the cope. This channel must taper from the runner, to the riser, like a nozzle. It is comparatively small at the junction with riser.

Here is the point where care and judgment must be used. If it is too large it will take the metal too fast, making it impossible to keep the pouring head full, and the scum will enter the casting, showing up as dirt. If it is too small it will not take metal fast enough, and the casting may not run, as it is poured rather cool. When pouring, as the pots empty the stream naturally grows smaller; this is another point to be watched or the head may sink, and the whole of the bubbly scum be sucked into the mold. When the head is successfully kept full, this method of gating gives clean castings.

In order to feed and prevent shrinking in the casting we have been considering it is prudent to put on a riser 3½ inches in diameter. It must not be put on top of the casting, but about an inch away from it, anywhere where convenient, connected with the casting by a good deep gate, filleted so as to break off hot, without breaking in. Carry the feeder up 4 inches above the cope. When the mold is filled, cover the pouring head and top of runner riser with sand bed on a weight, then fill up the feeder head. Shake out while hot, break off feeder and runners, and scrub the casting with a spade.

As the making of alloys of copper is a subject that has been ably and extensively dealt with by writers, and before this association, it would be only repetition to mention the same here, further than the remark that it is very seldom that the practical metal mixer gets a chance to use wholly new materials. The scrap brass must be used up somewhere, and it is generally cheaper than a new mixture. To use it judiciously is where the art of metal mixing comes in. The mixer must be able to judge of the quality of the metal in the different pieces of scrap as he sorts them out.

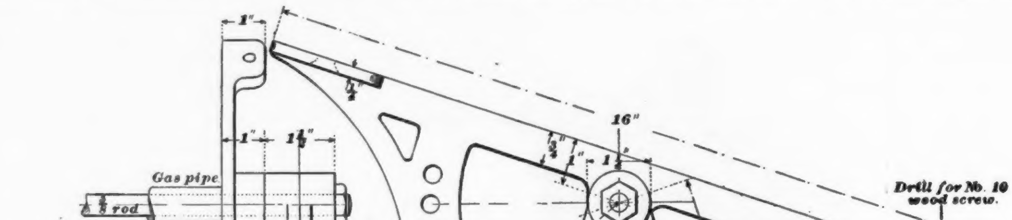
Bells, bearing brasses and bushings are, as all practical men know, generally hard brass. Car brasses justly come under suspicion; they are often made of old copper buttons and scrap containing iron. They must be used sparingly in finished work. Valves and small red brass scrap are generally soft, and may be used accordingly. Soft brass may be stiffened by the addition of hard scrap, and porosity guarded against by adding yellow brass scrap.

Scrap metal has a great tendency to make dirty castings; guard against this by cleaning the metal before pouring. Bring the metal from the furnace hot, add the new metal mixture. After stirring thoroughly scrape down the sides and bottom of the pot, inside, with the skimmer, which had better be of ⅝-inch round iron; stir again and skim off. If the metal is hot enough, there may be time to repeat the stirring and skimming. A surprising quantity of dirt is removed from the metal in this way. When pouring, bridge the lip of pot with the skimmer, holding back all dirt. The writer has made key heads, scaling 30 pounds each, with only 1-16 inch stock allowed on both sides for finishing, out of common scrap by using care as aforesaid, and not lost one out of sixty.

A HOME MADE DRAWING TABLE.

W. H. Sargent.

If any ambitious young mechanic desires to work out his leisure evenings some of the problems which confront him during the day, or if he wishes to undertake a course of home study in mechanical drawing, he will soon discover the need of a suitable drawing table. The top of a bureau is inconvenient, his landlady's dining table is inaccessible and any arrangement of "trestles" will not prove satisfactory. In some offices wooden horses are used. Unlike carriage horses, these are better before being broken. The accompanying sketch shows a design for a cheap and serviceable drawing stand, constructed largely of pipe. Two patterns only are needed, both of which may easily be made by one not a pattern maker, and two castings of each are required. One of the segmental arms has a row of ⅜-inch holes drilled at suitable intervals, into which a tapered ⅜-inch pin engages to hold the table at any angle. Each end of the stand is formed of two pieces of ½-inch gas pipe, screwed into an A-shaped casting. These are tied together lengthwise at the bottom by a ½-inch pipe on each side, screwed in with a right and left hand thread, and at the top with a ⅜-inch rod, with a nut on each end. A ⅜-inch pipe cut the right length to fit in between the arms is slipped on over the rod. The construction of



HOME MADE DRAWING TABLE.

the locking pin is fully shown in the drawings and need only be applied to one end of the stand. A set of furniture casters is inserted in the corners and a casting stolen from a hot air register serves both as a foot plate and as a tie for the bottom of the table. The height of the table is shown to be fixed at 37 inches. For fifteen years I have worked over an adjustable table without changing the height oftener, probably, than once a year, especially when used in connection with an adjustable stool, and a comparison of all the tables in our office showed a variation of not more than 1 inch, the average height being 37 inches, which I have adopted in the sketch.

* * *

Subscribers who desire a copy of the index for Volume IV. of Machinery, of which this number is the last issue, can obtain the same by sending a postal card to this office.

MARINE ENGINE DESIGN.—6.

CYLINDERS.

WILLIAM BURLINGHAM.

Marine engine cylinders require as much, if not more, thought than any other part of the engine, for this is the part where the unnecessary weight will creep in. It is the place where the steam is the most often throttled, thereby reducing the efficiency of the engine by a large percentage.

It must be kept in mind in fixing the thickness of the walls that, in addition to supporting the uniformly distributed load due to the steam pressure and the provision made for reboring, these walls must take, without practical deformation, the local pull due to the frames and columns, and all webs and ribs should be carefully located so as to transmit this pull over as large an area of the wall as possible.

It was formerly the custom, and is now in many shops, to make all large cylinders of 70 inches and over with double bottoms. This was deemed necessary for strengthening the cylinder, although greatly increasing the liability of bad castings; but of late years the conical or dished head, heavily ribbed, has been advantageously substituted. When steam jackets are used, however, the double head is a necessity, and in this case the outer head should be cored between each rib, and after cleaning the sand out, a three or four-inch pipe tap plug is screwed in and riveted with a peneing hammer.

The best material for cylinder barrels is a good, strong cast iron, at least twice melted, with the resulting product free from all sand, blow holes or other imperfections. Cylinder liners should be made of close-grained cast iron, as hard as can be properly worked. Many English builders use compressed steel for the same purpose. But our practice gives the best results in the long run.

Where weight is not of great importance, a thing that seldom happens in marine engineering, inferior metal may be used, and the pieces made heavier, although this is not advised except in the very cheapest kind of tramp steamers, and they ought not to be built.

The best exemplification of light engines due to the use of good metal are those in the government ships; these are extreme cases, and we can hardly make a commercial engine as light, for the reason that we can command no such rigid inspection; if we could the cost would be too great. But as far as competition allows we should strive for that great desideratum in engine building—lightness and strength.

The methods of machining cylinders are practically the same in all large shops, and outside of the care necessary in keeping the work parallel and in alignment, there is but one thing that I wish to mention—that is, boring. Medium and large cylinders for vertical engines should be bored in a vertical boring machine, and those for horizontal engines in a horizontal boring machine. After this work is done, they should be handled very carefully, and the cylinders for the vertical engines always placed in a vertical position in the shop. If it becomes necessary to rest them in a horizontal position, the walls should be well stayed with struts of timber, as otherwise they are very liable to deformation; for instance, a 72-inch cylinder will flatten one-eighth of an inch on a diameter, if left undisturbed for only ten hours.

The ports are a most important part of the cylinder, and should be, in consequence, most carefully designed. The areas should be ample and the leads as direct as possible, as the shorter and straighter they are the more efficient the engine. The flat surfaces constituting the walls of the ports are often poorly braced. These should be carefully stayed, steel screw stays being advantageously used for this purpose. If the ports are small, they will wiredraw the steam, choke up the exhaust and give poor indicator diagrams; yet at the same time too large ports will unduly increase the size and weight of the cylinders, valves and valve gear. Thus a compromise must be effected in which all the important points, by yielding a bit to each other, will give the best practical results.

The use of liners is very prevalent, and is by all odds the best way of building an engine. The engine is heavier, but its life is lengthened, and it is a comparatively easier and cheaper job renewing the liner than it would be to substitute a new cylinder. The space between the cylinder and liner furnishes the required steam space if steam jackets are used.

The usual method is to steam jacket the high pressure around the working liners and the other cylinders around the liners and at both ends. The space left between the liners and the cylinder casings for large engines varies from ¾ inch to ⅞ inch, and for smaller engines it is ½ inch. All ribs should be cored out to allow of the free circulation of the steam and the free drainage of the condensed water. The drainage holes must be well towards the bottom of the jackets. The liner spaces and the cover ends are usually connected, either by holes cored in the casting, or by small copper pipes. The steam should be taken from the main steam pipe on the boiler side of the engine stop valve, and should lead to the highest part of each jacket, with a stop valve close to the jacket. There is also in each steam pipe a reducing valve, with a safety valve between that and the cylinder. Very large engines, from 8,000 to 12,000 I.HP., require a 1½ inch, from 4,000 to 8,000 I.HP., a 1-inch, and from 1,000 up to 4,000 I. HP. a ¾-inch supply pipe. The high pressure is usually jacketed with steam at boiler pressure, and the others from fifteen to twenty pounds above the highest pressure in their respective receivers, the reducing valve being capable of regulating this pressure.

The clearances in the cylinders should be as small as possible, and after the engines are set up in place and connected, the volume of the clearance at each end of each cylinder should be carefully measured by filling the space with water or oil, and the result plainly marked on a conspicuous part of the casing. Marks are also made on the crosshead guides, showing the position of the pistons when the clearances were measured. It is important that the hole in the crosshead end of the cylinder be large enough to allow of the use of a boring bar of the requisite stiffness.

On large cylinders a manhole of about 15 inches diameter is usually inserted in the lower head, to allow examination of the under side of the piston and the top of the stuffing box; also one in the center of the top cover, for examination of the upper part of the cylinder without the necessity of disconnecting the heavy cylinder head.

The steam and exhaust passages should be thoroughly pickled and cleaned before the insertion of the liner.

CYLINDER BARRELS.—The thickness of cylinder barrels may be found by the following formulæ, the strains as given under "S" allowing a thickness ample for reboring, column strains, etc.

$$P = \frac{S}{1 + \frac{r}{t}} \qquad S = \frac{P(r + t)}{t}$$

P = Maximum pressure in the cylinders.
r = Radius of cylinder.
t = Thickness of cylinder.
S = 1,500 pounds, for cylinders without liners.
S = 1,900 pounds, for cylinders with liners.

The cylinder liners vary from 85/100 to 95/100 of the thickness of the cylinder barrel.

If forged steel liners are used they should be about 76/100 of the barrel thickness, and the piston packing rings should be made of hard bronze.

The liners of horizontal cylinders should be from 1/16 to ⅛ thicker than given above.

The piston rings usually overrun the counterbore about ¼ inch, the counterbore being from ⅛ to ¼ inch greater in diameter than the bore of the cylinder. The thickness of the barrel outside the counterbore should then be made the same thickness as the rest of the cylinder.

The width and thickness of the flanges vary as the diameter of the studs, and it is first necessary to fix this diameter. The pitch should not be less than 3.75 times nor more than 4.5 times the diameter. The nuts are usually of the deep class—that is, ¼ inch, or so deeper than the diameter of the stud. Steel studs are preferable, and should be always fitted with iron nuts to avoid seizing, and screwed into the flange from 1¼ to 1½ times their diameter. The width of the flange is made from 2¾ to 3 times the diameter of the stud, the pitch circle being located outside the center of the flange, the corners of the nuts being as close as possible to the outside edge, thus allowing a wide packing joint between the inside of the studs and the inside of the flange.

The steel studs should not be subjected to a higher tensile

strain than 4,500 to 5,200 lbs. for 1¼ to 1½ diameters, and 3,500 to 4,500 lbs. for ⅞ to 1⅛ diameters; this strain to be figured per square inch of area at the root of the thread. Smaller studs should have proportionately smaller strains, as the initial stress due to the setting up of the nut must be considered in addition to the stress due to the load on the cylinder head.

When a nut is screwed up tightly, as in making a joint, the stud is subjected to two stresses, viz., tension and twisting, and on small studs the wrench, except in very skilled hands, gives a greater proportionate twisting stress than on larger ones. The figures given above allow for these stresses in figuring the working strength of the stud. It is better to use the same size studs on all the cylinders.

The top of the piston on its up-stroke should stop but a little above the lower edge of the cylinder port, as otherwise the side pressure would be too great to allow of an even wear of the piston on the walls of the cylinder.

should be of taper section, to allow of easy withdrawal from the sand.

The thickness of the cover proper is found by the use of the flat surface formula given in article 4* of this series. T in the above formula may vary from 1,500 to 2,000 for this purpose. In using it, consider the flat surface as enclosed between two of the ribs. It is triangular in section, and must be laid out as shown in Fig. *B*. From a point in the triangle draw lines dividing it into three; find the center of gravity of each small triangle and proceed as in the given formula.

The thickness of metal surrounding the stuffing box or manhole should be of the same thickness as the bottom web, and connected to it and the ribs by good large radii.

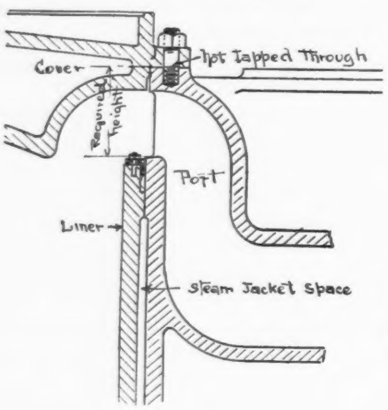


FIG. A.

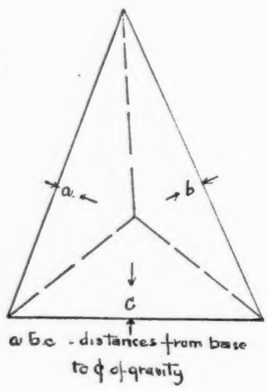


FIG. B.

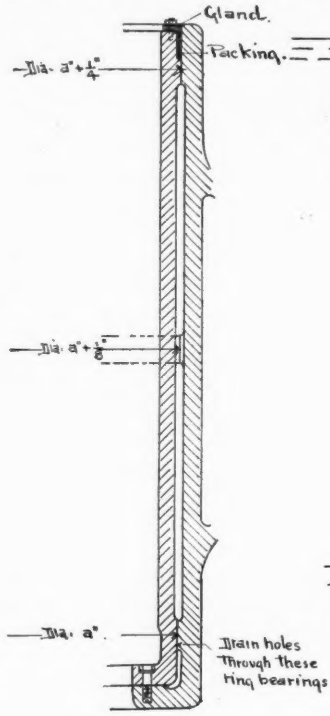


FIG. F.

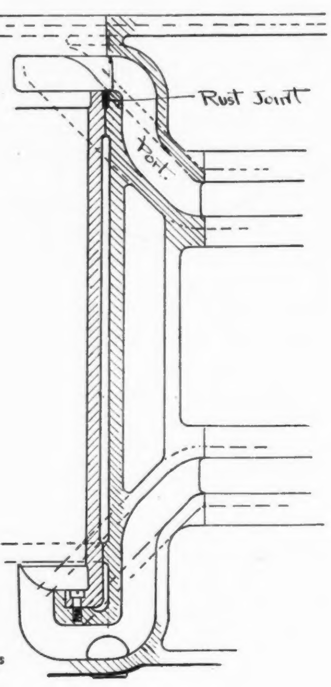
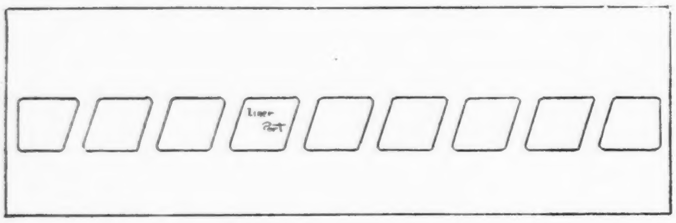


FIG. G.



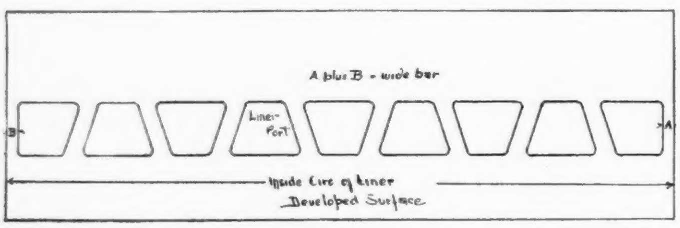


FIG. D.

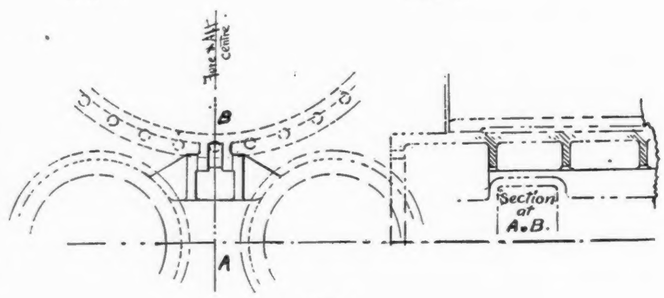


FIG. L.

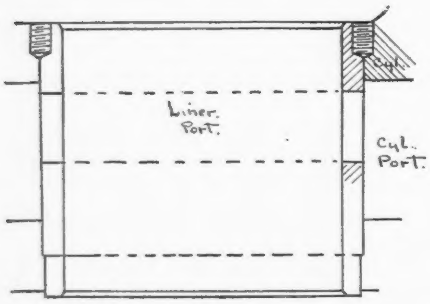


FIG. I.

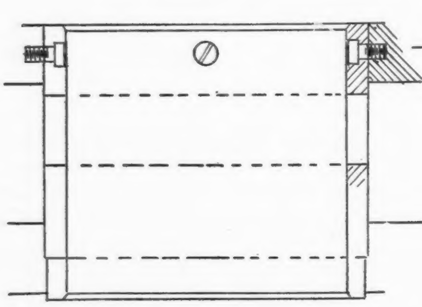


FIG. J.

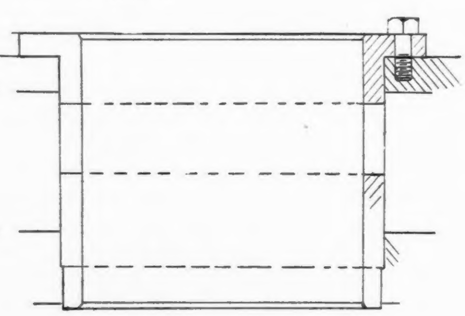


FIG. K.

The depth of the cover is usually settled by the depth of the port and the necessity of leaving sufficient metal over the port to enable the stud to be screwed in without breaking through the walls, Fig. *A*. Again, if it is found that the valve chests are a little longer than the cylinder, the face of the flange is carried up until both flanges are in the same plane. The depth in any case should never be less than from four to five times the thickness of the metal in the cover. The number of ribs in the cover and ends varies from six to ten, according as they give the best distribution for the strains, due to the frames or columns, and their thickness is usually the same as the cover. They

CYLINDER PORTS.—These are often made too small, throttling the engine, and thus reducing the capacity or horse power to a disproportionate degree. The area should be such, for the high pressure carried nowadays in triple-expansion engines, as to give the following speed of steam per minute, viz.:

High pressure port, 5,000 feet.
Mean pressure port, 6,000 feet.
Low pressure port, 8,000 feet.

This is not a hard and fast rule, and these speeds may be ma-

* December, 1897.

terially exceeded without injury; but for good, smooth working at high speeds, the above figures are the best.

The formula for finding the speed of the steam through the ports is as follows:

$$\frac{\text{Revs. per min.} \times \text{Stroke in feet} \times 2 \times \text{Area of cyl. in inches.}}{\text{Area of port in inches,}}$$

equals speed of steam through the port. Fig. *G* shows one of the best shapes for ports. It offers a simple job for the pattern-maker and founder, and affords a maximum straight lead for the steam.

The width of the ports is usually equal to the diameter of the cylinder, although they are often made less.

The depth of the port in the valve chest liner is determined by the travel of the valve, and the diameter of the liner must be such that 70 to 75 per cent. of its inside circumference, multiplied by the height of the port in same, gives the requisite port opening, or one-half of this if two valves are used, etc.

The general shapes of the openings in the liners is shown in Fig. *D*, the wide bar being so located that it offers a wearing surface for the split in the valve rings.

It is customary to cast the cylinder and chests in one piece, but many good firms cast them separate and bolt them together. The advantages claimed for this method, however, do not compensate for the increased work.

RECEIVERS.—For compound engines, cranks at right angles or thereabouts, the receiver capacity should be from one to one and one-half the capacity of the high-pressure cylinder.

For the ordinary triple-expansion, three-cylinder engine, the receiver space may be very small, the space around the valves and ports affording all that is necessary.

For quadruple engines the receiver capacity varies as the designer. The following ratios of capacity give an equal load on each crank and the maximum output consistent with this equality:

First receiver, three times capacity HP. cylinder.
Second receiver, two times capacity, first mean.
Third receiver, two times capacity, second mean.

CYLINDER LINERS.—There are several methods by which the liners may be secured in the cylinders. Figs. *F G* show two that are probably the ones that are most used. Fig. *G* is the method usually employed in the merchant service, and *F* is the United States Government practice. The latter is the more expensive, but the best, although the other two methods are good enough for most commercial work. In securing these liners, it is necessary that one end of the liner be left free to allow for the difference of expansion that occurs between the cylinder and the liner.

VALVE CHEST LINERS.—Figs. *I J K* show methods of securing valve chest liners. The three methods are all good practice, but *I J* mean a smaller valve chest. The thickness of this line is about the same as that of the chest. Where the balance pistons are omitted, the upper piston valve is better made from ⅛ to ¼ of an inch larger in diameter than the lower, the steam being inside steam. If outside steam is used the lower valve must necessarily be the largest.

STUFFING BOXES.—These boxes are all of the same general design. They should be the same size, if possible, for all cylinders, and in these days of high steam should always be fitted with metallic packing.

The following table gives the sizes of boxes suitable for metallic packing, such as Katzenstein's and others. The bottom of the stuffing box must conform to the style of packing used:

Joints for cylinder heads, manhole bonnets, chest covers, etc., should be made with some sort of asbestos metallic packing, as thin as possible consistent with a good joint.

The face for a flat slide valve is often made a separate casting of good hard iron fastened to the cylinder by brass cheese-head screws countersunk below the surface; for better distribution of the oil on this face, these holes should be joined by grooves, the screws must be secured against backing out by some style of locking device; usually a small nick is made in the head and valve seat face.

Rectangular valve face covers are calculated by the formula for flat surfaces given in Article 4 of this series.

The covers should be stiffened by ribs of a depth not less than three times the thickness of cover, spaced so as to put the metal under the same strain as given for cylinder heads; the outside edge of the rib, preferably of the parabolic type, if possible. If the cover is curved, the metal may be made light without loss of strength.

TABLE OF STUFFING-BOX SIZES.

Dia. of rod, inches.	Dia. of box inside, inches.	Depth of box, inches.
1	1¾	2¾ to 3½
1¼	2¼	3 to 3¾
1½	2½	3¼ to 4
1¾	2¾	3½ to 4¼
2	3¼	4¼ to 4⅞
2¼	3½	4½ to 5⅜
2½	4	5¼ to 6
2¾	4½	5½ to 6¼
3	4¾	6 to 6⅞
3½	5¼	6½ to 7
4	6	7½
4½	6½	7½
5	7¼	8
5½	7¾	8
6	8½	9
6½	9	10
7	9¾	10½

COLUMN FEET.—In designing these feet, it must be remembered that the whole load is taken by them, and the strain is always suddenly applied, consequently ample section of metal should be provided and be well spread over the cylinder sides and bottom. The flanges for attaching the engine columns are often set so close to the cylinder that it is difficult to set the nuts up on the bolts; there should be ample clearance and in all cases bolts should be used. At least two of the bolts should be body-bound.

The area of the section through these feet must be such that the tensile strain does not exceed 400 to 600 pounds per square inch, the latter being the maximum.

In compound engines the cylinders may be bolted together, but in triple and quadruples they are separate from each other, thus allowing for expansion and only held from motion athwartships by slides, as shown in Fig. *L*. It is sometimes customary in quadruples to bolt the cylinders together in couples, the high and first mean, and the second mean and low pressures together.

The cylinders of vertical engines should never be stayed to the ship. Many authorities say that no part of the engine should, but if the ship is well and stiffly built, judicious staying from the top of the engine columns fore and aft and athwartships has in many cases effectually reduced excessive vibration. These engines were well and strongly built, but of a high rate of speed.

The description of the cylinder attachments will follow in the next article.

* * *

The ease with which water will work itself through an exceedingly small space was well illustrated by an experiment that a well-known steam engine company had to perform to test the efficiency of some dash pots of unusual construction. These dash pots were going on cylinders of unusual size, and to ensure the valves closing at short cut-off and at high speed, conditions under which the ordinary type of vacuum dash pot is not as effective as could be wished, positive acting dash pots were designed, in which the closing action was to be from the direct pressure of the steam. There was a plunger, perhaps 3 inches in diameter and 6 inches long, working in a cylinder; the steam operated against this plunger, there being, however, a body of water between the plunger and the steam, so that the latter did not come directly in contact with the cylinder. The cylinder was bored and reamed very carefully to exact size, care being taken that there should be no taper to the hole nor any springing in, due to clamping in the chuck when it was being bored in the lathe. The plunger was ground accurately to size, exactly .0005 inch smaller than the cylinders, and grooves were turned in one end in which it was believed that water would gather and act as water packing. The dash pots were tested under water pressure and at 135 pounds, the boiler pressure at which the engine was to run, the water came by the plunger in a fair-sized stream. The plunger was finally made tight by using metallic packing, and the experiment showed conclusively that such packing must be made very nicely indeed to fill its requirements satisfactorily.

THE CENTER OF GRAVITY.—I.

CONVENIENT METHODS FOR FINDING THE CENTER OF GRAVITY OF LINES AND PLANE FIGURES FOR EVERYDAY USE IN THE DRAFTING ROOM.

BENJ. F. LA RUE.

The force of gravity is exerted upon every one of the particles composing a body. The number of gravity forces acting upon a body may therefore be considered equal to the number of particles composing it. The sum or resultant of these individual forces constitutes the aggregate gravity of the body; and that point in the body at which may be applied a single resultant force that will have an effect the same as that of all the gravity forces acting upon its separate particles, is the center of gravity of the body. The center of gravity of a body will, therefore, be given by the position of the resultant of all the gravity forces acting upon its particles. If a body is supported upon its center of gravity, it will be in equilibrium in any position, and will have no tendency to rotate. This is, in substance, a definition that is sometimes given for the center of gravity.

Each one of the gravity forces acting upon the particles of a body, except those forces whose lines of action pass through its center of gravity; is the force of a moment,* and has a rotative effect. The lever arm of each moment is the perpendicular distance between the line of action of the force and the center of gravity of the body. Every such moment tends to produce rotation in the body, and as rotation is not produced when the body is supported upon its center of gravity, it follows that the center of gravity of a body is that point at which the moments of all the gravity forces acting upon its particles balance each other, or, in other words, at which the resultant moment of all the gravity forces is zero. This fact may be made use of in determining the position of the center of gravity. Different methods are employed for finding the center of gravity, according to the form of the body, or the arrangement of the system of bodies, for which it is to be found. Some of these methods will now be noticed.

CENTER OF GRAVITY OF LINES.

The word line, as here used, means a material line; that is, a homogeneous body of given length, having a uniform and very small transverse section, such as a fine wire. A theoretical line would, of course, have no width or thickness and, consequently, no mass and no gravity.

A SINGLE, STRAIGHT LINE.—The center of gravity of a straight line is at its middle point. If we conceive the line to be composed of uniform individual particles, the gravity of every particle will be the same; and the distance of each particle on one side of the middle point, from that point, will be the same as that of the corresponding particle on the opposite side. Hence, the moments of all the gravity forces acting upon the particles, taken about the middle point of the line, will balance, and that point will, therefore, be the center of gravity of the line. A straight line will balance upon its middle point; if supported upon that point, it will be in equilibrium in any position, and will have no tendency to rotate.

TWO STRAIGHT LINES OF DIFFERENT LENGTH.—Let $A\ B$ and $C\ D$ Fig. 1, be two straight lines of any lengths and having any positions with respect to each other. The center of gravity of each line is at its middle point, as O and O'. If these two centers of gravity be connected by the straight line $O\ O'$, the center of gravity of the system will be somewhere on this line. Draw the line $O\ B'$ equal and parallel to $O'\ B = \frac{1}{2}\ A\ B$; on the opposite side of $O\ O'$, lay off on the line $B\ A$, at length $O'\ C'$ equal to $O\ C = \frac{1}{2}\ C\ D$, and draw $B'\ C'$. The point g, where the lines $O\ O'$ and $B'\ C'$ intersect, will be the center of gravity of the material lines $A\ B$ and $C\ D$. If the given lines are parallel, $O\ B'$ is simply laid off on $O\ D$ prolonged. The distance $O'\ g$ may also be calculated; it is given by the equation:

$$O'g = \frac{C\,D \times O\,O'}{A\,B + C\,D}.$$

PERIMETER OF THE TRIANGLE.—Let $A\ B\ C$, Fig. 2, be any plane triangle, in which D, E and F are the centers of gravity of the three respective sides. Join any two of these centers, as D and E, and on this line determine, by the method just explained, the center of gravity c of the two sides joined. To do this, join E and F; the line $E\ F$ will be equal and parallel to $C\ D$; then lay

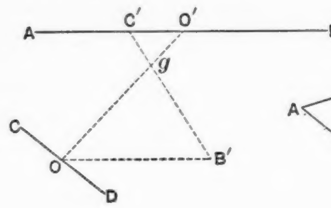


FIG. 1

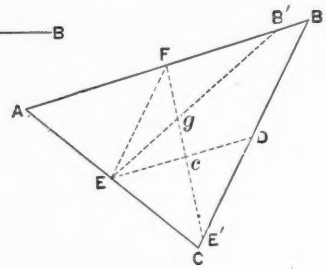


FIG. 2.

off $D\ E'$ equal to $C\ E$; the intersection of c of the lines $D\ E$ and $E'\ F$ will be the center of gravity of the sides $B\ C$ and $C\ A$. Now lay off $F B'$ equal to $\frac{1}{2}\ A\ E + \frac{1}{2}\ B\ D$ and draw $E\ B'$; the intersection g of the lines $E\ B$ and $c\ F$ will be the center of gravity of the three sides, or perimeter, of the triangle.

CIRCULAR ARC.—Let $A\ B\ C$, Fig. 3, be the arc of a circle whose center is at O; $A\ C$ is the chord and B is the middle point of the arc. The center of gravity of the arc will be at some point g on the radius $O\ B$, at such distance from O that

$$O\,g = \frac{A\,C \times B\,O}{A\,B\,C}.$$

CENTER OF GRAVITY OF PLANE SURFACES.

A theoretical surface has no thickness and, therefore, no mass and no gravity. In mechanical problems, however, it is often necessary to find the center of gravity of a plane figure, or, more correctly, that point in its surface corresponding to what would be the center of gravity of the figure, were it a material body of uniform thickness. As here used, therefore, the word surface may be taken to mean a material surface, such as a very thin, homogeneous plate or a piece of cardboard.

AXIS OF SYMMETRY.—If a plane figure can be divided by a straight line in such manner that the two parts of the figure will exactly coincide when folded together along the line, the line so dividing the figure is called an axis of symmetry. The diameter of a circle and the diagonal of a square are axes of symmetry for those figures, etc.

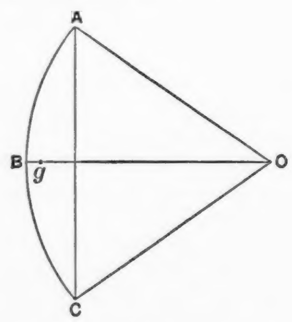


FIG. 3.

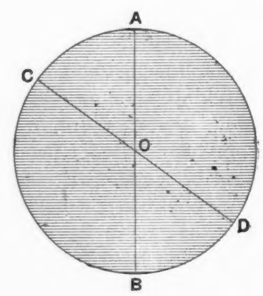


FIG. 4.

The center of gravity of a plane figure having an axis of symmetry, must lie in such axis; if the figure has more than one axis of symmetry, the center of gravity must be at the intersection of the axes. Let $A\ B$, Fig. 4, be a diameter of a circle whose center is at O; it is also an axis of symmetry, for, if folded along this diameter, the two parts of the circle will exactly coincide. If, now,

*A moment is the measure of the relative effect of a force acting upon a lever arm; its value is expressed by the product of the force into the perpendicular lever arm.

we consider the area of the circle to be composed of straight lines perpendicular to *A B*, as indicated in the figure, the diameter *A B* will bisect each line; in other words, it will pass through the center of gravity of each line composing the area of the circle. Hence, the center of gravity of the entire system of lines composing the area of the circle, which will be the center of gravity of the circle itself, must be some point in the diameter *A B*. In like manner it can be shown that the center of gravity of the circle must lie in any other diameter, as the diameter *C D*. Consequently, the center of gravity of the circle must be at the center *O*, the only point common to all diameters. That the center of gravity of the circle is at the geometrical center of the figure is so evident as to scarcely require proof; but the circle serves as a very simple example to illustrate the process of reasoning, which applies to any plane figure having two axes of symmetry, such as a circle, ellipse, rectangle, rhombus, equilateral triangle, square, or any regular polygon, and also to the perimeters of such figures.

The positions of the centers of gravity in various plane figures are as follows:

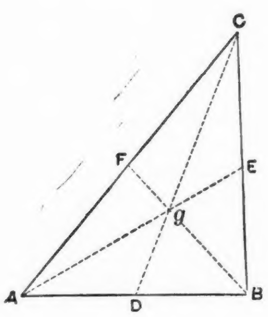


FIG. 5.

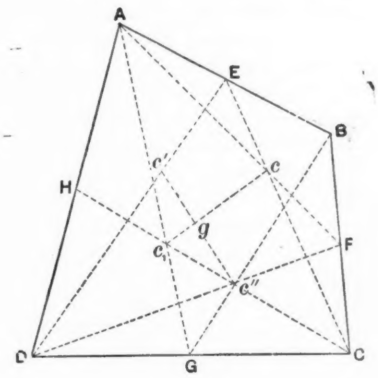


FIG. 6.

SEMICIRCLE.—In its axis of symmetry, at a distance of .4244*r* from the center of the circle, *r* being the radius of the circle.

SECTOR OF A CIRCLE.—In its axis of symmetry, at a distance *x* from the center of the circle, the value of *x* being given by the equation:

$$X \times \frac{2cr}{3l},$$

in which *c* is the chord and *r* the radius of the circle, and *l* the length of the arc.

QUADRANT.—In its axis of symmetry, at a distance of .4244*r* from each radial side, or .6002*r* from the center of the circle, *r* being the radius of the circle.

SEGMENT OF A CIRCLE.—In its axis of symmetry, at a distance *x* from the center of the circle, the value *x* being given by the equation:

$$x = \frac{c^3}{12a},$$

in which *c* is the chord and *a* the area of the segment.

PARABOLIC SURFACE.—In its axis of symmetry, at 2-5 the length of the axis from the base.

SEMI-PARABOLA (SURFACE).—At 2-5 the length of the axis of the parabola from the base, and 3/8 the length of the semi-base from the axis.

SURFACE OF A HEMISPHERE.—At the middle of its axis or center radius.

GRAVITY AXIS.—It is not necessary, however, for a plane figure to have two, or even one, axis of symmetry, in order that its center of gravity may be determined. Any plane figure can be balanced upon a knife edge. The position of the knife edge will be defined by a straight line in such position that the moments of all the gravity forces acting upon the particles composing the surface on one side of the line will just balance the moments of those on the other side. This line, about which the moments of the gravity forces balance, will here be called a gravity axis. By a process of reasoning analogous to that employed in finding the center of gravity of the circle, it can be shown that every gravity axis of a plane figure contains the center of gravity of the figure. Consequently, the intersection of any two gravity axes determines the position of its center of gravity. It should be noticed that in many practical problems it is necessary to find the position of a gravity axis only, the exact center of gravity not being required.

TRIANGLE.—Let *A B C*, Fig. 5, be any triangle; the line *C D* extends from the vertex *C* to the middle of the opposite side. If we consider the area of the triangle to be composed of straight lines parallel to the base *A B*, each of these parallel lines will be bisected by the line *C D*; that is, the line *C D* will pass through the center of gravity of each of the parallel lines. Every line composing the area of the triangle, and, consequently, the triangle as a whole, will just balance upon the line *C D*, which will be a gravity axis of the triangle. If, also, a line be drawn from any other vertex of the triangle to the middle of the opposite side, as the line *A E*, it will also be a gravity axis. As the center of gravity must lie in both these gravity axes, it must be at their intersection *g*. It is not necessary, however, to draw more than one gravity axis, in order to determine the position of the center of gravity of a triangle. If a line be drawn from any vertex to the middle of the opposite side, the center of gravity of the triangle will be on this line and at two-thirds the length of the line from the vertex. Thus, the center of gravity *g*, Fig. 5, is at two-thirds the length of *A E* from *A*, two-thirds the length of *B F* from *B*, and two-thirds the length of *C D* from *C*; its position may be located on any one of the lines.

TRAPEZIUM.—There are several quite satisfactory methods for finding the center of gravity of a trapezium. The following simple method is probably as expeditious as any, and, as it depends directly upon the method just explained for finding the center of gravity of a triangle, and is readily connected with that method, it has the advantage of being easily remembered.

Let *A B C D*, Fig. 6, be any four-sided plane figure. Consider it first to be divided into the two triangles *A B C* and *A D C*. The points *E*, *F*, *G* and *H* are the centers of the respective sides, the common side *A C* not being drawn. The intersection *c* of the lines *A F* and *C E* is the center of gravity of the triangle *A B C*, and, similarly, the intersection c_1, of the lines *A G* and *C H* is the center of gravity of the triangle *A D C*. The line $c\,c_1$, connecting these two centers of gravity, will be a gravity axis of the entire figure. The trapezium is then considered to be divided into the triangles *B A D* and *B C D*, and, by a similar construction, the position of the gravity axis $c'\,c''$ is determined. The intersection *g* of these two gravity axes will be the center of gravity of the trapezium.

For this construction, it is not necessary to draw the entire portion of each constructional line, as shown in the figure, but only such portions of the lines as are necessary to locate their intersections. Some may prefer the construction shown in Fig. 7; it is the same as that shown in Fig. 6, except that only one gravity axis is drawn for each triangle, and the center of gravity of the triangle located at two-thirds the length of the axis from its vertex.

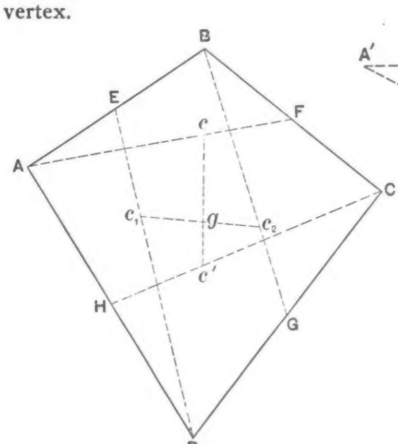


FIG. 7.

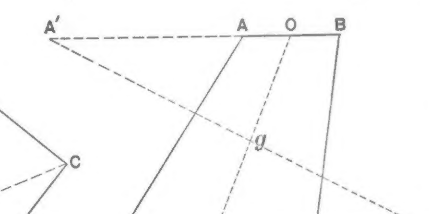


FIG 8.

TRAPEZOID.—If the figure is a trapezoid, the following construction, taken from "Trautwine's Engineer's Pocket Book," is a very simple method for finding its center of gravity. Let *A B C D*, Fig. 8, be any trapezoid for which the center of gravity is to be found. Prolong the two parallel sides in opposite directions, making each prolongation equal to the other side, and join the extremities of the prolongations by a straight line; also join the centers of the parallel sides. The intersections of these lines will be the center of gravity of the figure. Thus, in the figure, *A A'* is made equal to *B C*, and *C C'* equal to *A B*, and the extremities of the prolongations joined by the line *A' C'*, while the line *O O'* joins the centers of the parallel sides; the intersection *g* of the lines *A' C'* and *O O'* is the center of gravity of the trapezoid.

In the next number, methods for determining the center of gravity of irregular figures and solids will be given.

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SEPTEMBER, 1898.

Three of the four data sheets contained in the insert of this issue are reproduced from the gearing plates published in the June number. The fourth sheet is made up from the force and running fit and hole sizes contained in the article by Mr. A. A. Fuller in the November, 1897, number. The sheet is intended to be cut into four parts of standard 6 x 9 size, and holes punched as indicated for binding in note book form. These inserts will be published quarterly for the present, thus giving every reader sixteen data sheets at the end of the year, containing notes, diagrams and formulas that will be of great technical value. These sixteen sheets will make a very respectable nucleus for a mechanical note book. The material for them will, as in this instance, be derived in part from articles appearing in our reading columns; but we shall be glad to have draftsmen or others make suggestions or send us any notes of their own that they think suited to the purpose. It will be noticed that the insert is printed on strong manilla paper, that is calculated to resist both wear and dirt. A simple and satisfactory binder for the sheets can be made by cutting out two pieces, 6 x 9 inches, one of heavy cardboard, and the other of flexible cardboard or leather. With holes punched in the ends corresponding to the holes in the data sheets, these pieces, with the data sheets between them, can be bound together with two metal paper fasteners. The holes are placed just 2¾ inches apart, this being the dimensions of the punches furnished with letter files, and which can conveniently be used for punching these sheets.

* * *

Manufacturers of machine tools with foreign connections are from four to six months behind their orders, 60 per cent. to 90 per cent. of which come from abroad, with no sign of cessation. Meanwhile, domestic business has equalled almost any midsummer in dullness, according to the statements of dealers East and West, with few exceptions. But the general business improvement throughout the country, the gradual increase in the number of men employed in many manufacturing lines, the advance in iron and steel, the continued low rates for money and the abundant crops of 1898, remind an observer of a mighty flood gathering force to sweep everything before it; and the question arises—what will our machine tool builders do when the domestic trade of this country attains its normal volume?

* * *

THE "OREGON."

The recent run of the warship "Oregon" from California to Cuba, and her subsequent participation in the fight at Santiago, coming out at the conclusion of her run, if we may judge by her speed and behavior in the fight, in rather better condition than when she started, is, so far as known to the writer, the most remarkable performance on record of a modern armorclad of her armor and armament. It might have been believed that a vessel of her class, through extreme good fortune, would have made a continuous run of 15,000 miles under high steam, coming in at the finish with energy enough left to crawl up to dry dock under her own steam, but that she should make the run in the time she did in condition to go into a sea fight in which she outdid herself in the matter of speed, emphasizes something almost universally overlooked in such matters. That is the part that the mechanic, the engineer and the fireman play in making such achievements at all possible.

We shall never cease to hear of the part played by the Union Iron Works, where the "Oregon" was built, and it is right that this should go emphatically on record, for it was altogether creditable. It is pleasant to know that in that far-away part of the country, where it was hardly to be expected there was enough of that solid kind of skill and mechanical ability necessary to build, on time, a warship of the class of the "Oregon," they have produced a vessel equal, at least, to anything ever set afloat from the most renowned ship building establishments in the world.

To equip such a fighting monster with the machinery of propulsion and what-not, loaded as she is with iron and steel till it seems almost debatable whether she will float or sink, and to support the machinery on a foundation that at the best is twisted and warped out of shape by blows from the water and giant blows from the guns that help to weight the vessel out of shape by their gravity and pound her out of alignment by their recoil, requires fine skill of workmanship, without which all efforts to make such a record as the "Oregon" has made would be unavailing. It is that kind of skill that forges, turns, bores and aligns and otherwise gets parts and pieces into shape peculiar to their purposes under conditions most unfavorable. Somehow we never hear of patriotism in blue overalls. And yet we have a right to believe that many a blow was struck on the engines and the boilers and other machinery of the "Oregon" that had something behind it besides pay day and Saturday night.

The name of Captain Clark, who took the vessel half around the globe for the fight, and so gallantly managed to keep her where she was wanted during the engagement, and where she was likely to do the most good, is common as daylight, and he is rather more than deserving of all the praise he gets, but how many ever heard even the name of the chief engineer or his assistants, who kept the engines at their rythmic motions through both oceans and brought the great fighting machine around in time to make glory for others possible?

And what a forgotten quantity the firemen are, who throughout the fight turned inert coal into dynamic energy in a stoke hole temperature, compared to which the temperature that we drawl over and anathematize would be frigid, and at a rate that was modified by no personal considerations.

Abundant honor to the officers who look strictly after the business of a fight when it is on, and from wherever they can best observe it. Equal honor to the American sailor, who seems to get rid of even the suspicion of fear as easily as he does of his spare clothing when times get lively, but save a little for those who make aggressive fighting possible, in a location, during the fight, more suggestive of something infernal than anything else likely to come to mind.

We are free enough with honors, but we do not always distribute them judiciously—that is, fairly. We ought to see that some of the honor gets below decks. F. F. HEMENWAY.

AMONG THE SHOPS.

THE NATIONAL CASH REGISTER CO., DAYTON, O.—THE ORGANIZATION, SYSTEM AND SOCIAL CONDITION.

THE ORGANIZATION.

I shall begin this article by outlining the unique organization of the National Cash Register Co., familiarly known as the "N. C. R.," to which will be added the results of inquiry and observation.

Unfortunately I am not qualified by the personal experience of an employee, and can only speak from the superficial view of a visitor who has taken pains to inquire into the system of shop government in vogue at these works—the system devised by Mr. John H. Patterson, who is still president of the company. It was adopted about four years ago, and whatever abuses it may be subject to, it certainly seems like a step in the right direction.

The business is practically conducted by the employees, who govern themselves by a system of committees, at the head of which are the president and vice-president, "who occupy the position of a court of final resort." They also act in an advisory capacity as ex-officio members of all committees. Directly under them is the executive committee, composed of ten officers of the company, who control the general policy of the business and conduct its affairs. The management is then divided into three great divisions—the selling, the office and the making.

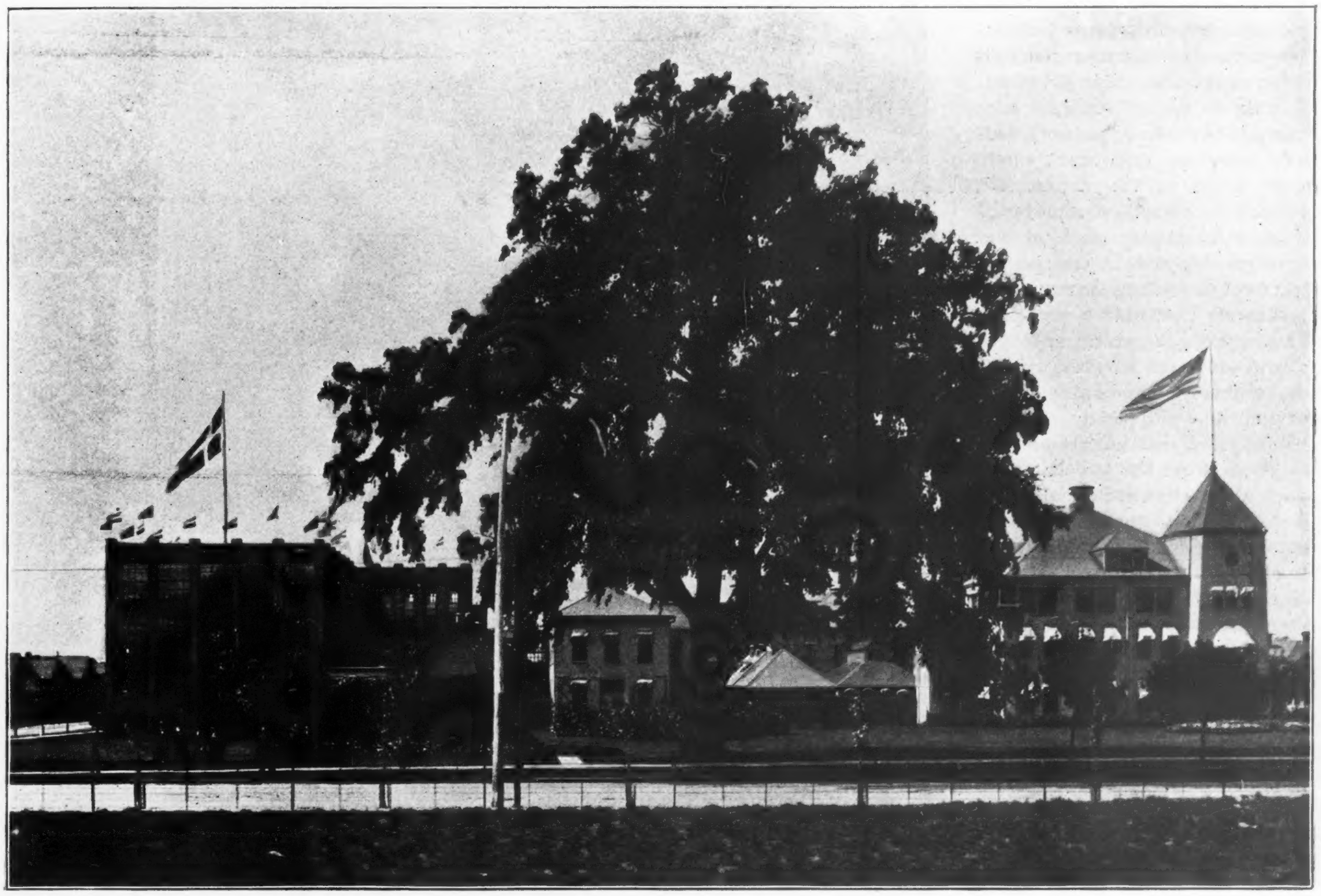
At the head of the Selling Division is the managing agent of the company, and the managing director, who is also at the head of the training school for agents.

The Office Division is managed by the "office committee," which is composed of the heads of all the office departments, with the assistant secretary as chairman.

The Making Division is in the hands of the secretary and a factory committee, which occupies the position of superintendent. There is no superintendent or general manager.

This factory committee is composed of the heads of five important factory departments. One member acts as chairman each month in regular rotation, and a majority can always act. There are also many committees attending to special duties, and besides the daily meetings of the executive and factory committees, there is a joint session once a week to take up matters common to both, such as patents, etc.

Then there is what is known as the Advance Club. This club consists of the officers of the company, the factory committee, all of those in authority in the offices and factory, and one hundred employees chosen alternately from the rank and file of the factory force. Members of the agents' school and visiting agents are also expected to be present. The object of this club is the advancement of the general interests of the company and the best methods of securing such advancement. In its meetings all suggestions and complaints are considered, and the proceedings are printed after each meeting in a paper called the "Advance Club Record," which is distributed to all employees, and a copy sent to each member of the selling force.



THE NATIONAL CASH REGISTER CO.'S WORKS

There are, also, occasional meetings of the entire factory force in addition to a general convention of agents annually. This convention lasts a week and the whole factory force is present at some of the meetings.

It is necessary to omit many interesting details, but the notes that follow indicate some of them.

THE WORKING OF THE ORGANIZATION.

A difficulty presenting itself to one of the employees would be submitted to the assistant foreman, and if it was an important matter it might pass on through the foreman and committees, and finally be decided by the president himself; but only matters of the greatest importance are referred to him.

Located in different parts of the factory are autographic registers for receiving complaints and suggestions. The writer takes the original, and the manifold copy remains in the machine to be taken up and acted upon by the Advance Club. With this method of making suggestions and the make-up of the Advance Club, due credit for an idea ought not to miscarry.

Every six months prizes are awarded for the best suggestions for improvement on registers, tools, machinery, shop systems or the general management of the business.

A grand reception (as usual) to the employees took place at Patterson Grove at the last semi-annual distribution of prizes, and after twenty diplomas and $500 in gold had been distributed among the twenty successful contestants, it was my pleasure to hear the president announce that the prize money would be raised to $600, so that a larger number of prizes could be awarded thereafter. The elaborate programme for the evening included a splendid display of fireworks, stereopticon views, refreshments and dancing, with two bands and other music, etc.

The company acknowledge that some of its best suggestions, even on business matters, have come from the employees. It is a significant fact that 240 out of the 550 suggestions offered during the past six months were adopted.

The "monitor boards" exhibited in various parts of the factory are another stimulative scheme. There is one for each of the three divisions, and it shows the efficiency of each department in its five points of greatest importance. Each week a banner is voted to the department obtaining the highest monitor board rating, and an excursion at the company's expense is one of the methods of rewarding several of the departments that obtain the highest average for the year.

The heads of the principal departments receive a commission on every machine shipped in addition to their salary, and $100 is divided monthly between the two salesmen making the best record of sales.

A visit to the factory clearly indicates that the company has a keen appreciation of self-respect and intelligence among its employees. Tool room apprentices must be graduates of some manual training or high school, and a girl who has not had at least one year in the high school is not accepted for any position.

The section where the factory is located is known as South Park, and everywhere are evidences of the elevating influences that the company seeks to throw about its employees.

No less than twenty-nine organizations exist here, and include a literary society, a band, bicycle club, Sunday school, kindergarten (tuition only $1.00 per year), improvement societies, etc, Headquarters are at the N. C. R. house, opposite the administration building, and the social settlement work involved is a feature that could not fail to result beneficially in any community.

According to an established practice, $50 will be distributed this year among the six residents of South Park for the best landscape gardening about their premises. Fifty dollars more in four prizes will be awarded for the best-kept premises aside from an artistic effect. Twenty-seven dollars are offered for the most artistic effects of vine planting, and $28 to boys and girls for the best kept back yards. Three women will come in for $15 for artistic effects of window gardens. Thirty South Park children are competing for five prizes, amounting to $50, for the best vegetable gardens. In this case everything, from the land to the tools used, including plowing and instructions, are provided at the expense of the N. C. R.

By the time a stranger has arrived at the entrance of the park he has seen and heard enough to more or less change such preconceived notions as I had, which were far different from my present favorable impression of the N. C. R.

In my own case I will admit that I was still cynical enough to think it was a grasping monopoly wearing a shallow mask of pretended philanthropy, and I was alert for any little indications that would enable me to penetrate the deception and read the expression of the face behind it.

The courteous treatment accorded all visitors and the freedom with which information is given without question is remarkable. I saw one couple ascend the steps and hesitate about entering. This was also noticed by one of the guides, who

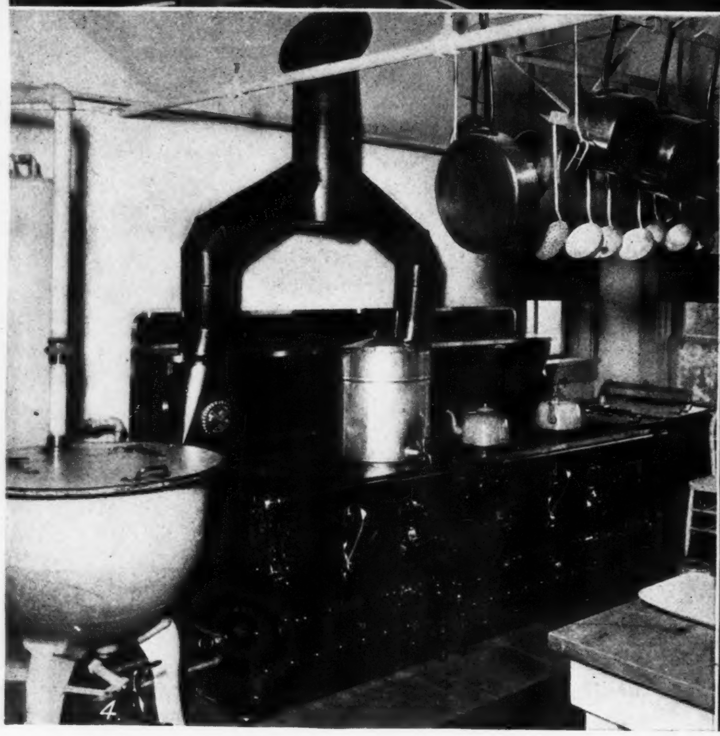


FIG. 1. FACTORY COMMITTEE IN SESSION.
FIG. 2. A GOOD SUGGESTION.
FIG. 3. WOMEN'S DINING ROO
FIG. 4. KITCHEN.

immedietely stepped to the door and invited the visitors in.

I made my first trip through the factory with the other unknown visitors that had assembled, in order to note their treatment, then returned as a representative of MACHINERY to secure more minute information and favorable opportunity was given without reserve.

EDUCATION IS AN ORNAMENT IN PROSPERITY, AND A REFUGE IN ADVERSITY.

'S DINING ROOM.

EN.

FIG. 5. REPAIRING AN ACCIDENT.

FIG. 6. PERAMBULATING LIBRARY.

is one of the signs ornamenting the entrance, but the first thing my eye hit upon after passing the outer door was this:

BOOKS ARE OUR BEST FRIENDS. THEY ENLIGHTEN OUR UNDERSTANDING WITHOUT LAUGHING AT OUR IGNORANCE.

As you approach the desk near the entrance you notice "Mr. Chas. A. F. Keller in charge of main entrance" upon it, and throughout the works are neat slabs of glass, with red borders, bearing the names of the departments, and the heads of each have their desks lettered similar to Mr. Keller's.

Here is another commercial establishment with a visitors' register. It was introduced March 16, 1896, and I was inquisitive enough to note that the first two volumes, covering a little less than two years, show an average of about twenty visitors for each work day. I was one of seventy-five, and ninety-nine autographs were enrolled the day previous. During the last week in May the visit of the delegates to the United Commercial Travelers' convention helped swell the number of visitors to a record-breaking figure of no less than 1,800 in one week.

Guides, who make six trips daily, are employed to show visitors through the works, where some 1,400 hands and 8½ acres of floor space are devoted to the manufacture of cash registers exclusively. Nothing is made that can be bought as good and as cheap as can be made, and it is estimated that another thousand hands are employed on cash register work elsewhere, besides some three hundred who devote their whole time to selling the product in different parts of the world.

The. N. C. R. has its own artists; also composing, press and bindery departments for doing their own printing, from stationery to advertising posters. "The Daily N. C. R." and at least four regular periodicals are also printed. Between 75 and 100 hands are employed in these departments alone.

Mr. Frederick Olmstead, one of the designers of the landscape gardening on Wooded Island, at the Columbian Exposition, was also designer for the N. C. R., and parts of the plant are known as the Administration Building, Machinery Hall and The Midway. Clean, transparent windows and attractive lawns take the place of white-washed glass and high board fences to be found in many places elsewhere.

On a typewritten list of tardy persons posted each morning inside the main entrance. I noticed that the time lost by each was given. There were only twenty on the list, but eleven of them either officers or members of the office division—that is impartial, to say the least.

At the trifling cost of one cent each (evidently to prevent it being a gift) the female employees are served with the essentials of a good, warm lunch in a large, tastefully decorated dining room on the fourth floor. Adjoining this are the kitchen, women's bath room and rest room, and everything about the N. C. R. is "painfully neat."

The buffing and polishing department has its own shower baths. Other baths are located in the Administration Building, Machinery Hall and foundry, and every employee, except piece workers, is allowed twenty minutes of the company's time each week for bathing. The baths are also open until 8 o'clock in the evening, and soap and clean towels are furnished to all by the company.

Right here I will add that everything is piecework to which

that plan can be applied, and from the figures given by the clerks in several departments, my estimate would place the piece workers between two-thirds and three-quarters of the total number employed.

Hot and cold artesian well water is supplied to all parts of the factory, and the hot air heating apparatus takes its supply from above the building in quantities sufficient for a complete change of air in the factory every fifteen to twenty minutes.

In short, the hygienic conditions prevailing in these clean and well-lighted structures are among the best to be found in a factory. The shop's "eye doctor" was given instructions for two weeks in a school for oculists and a neat set of instruments provided. A medicine cabinet with suitable supplies for emergency uses, etc., is also maintained.

The N. C. R. library of 700 or 800 titles has recently been made a branch of the public library, affording the help the free use of the public library books that make their appearance in the different parts of the shop at noon times, as shown by the perambulating library illustrated.

Since Mr. Patterson announced some time ago that he hoped to gradually diminish the working time until the eight-hour ideal was reached, there has been a reduction of fifteen minutes per day. At present the men receive 10 hours' pay for 9½ hours' work. The women begin an hour later than the men (both have an hour at noon) and leave fifteen minutes earlier, which enables them to avoid the inconvenience of crowded street cars, etc. They are also given fifteen minutes twice a day for calisthenic exercises, a half holiday Saturdays and one whole day each month with full pay. To these privileges are added white sleeves and aprons provided and laundered at the company's expense.

Instead of being a loss, the company claim that granting these privileges has been a source of great profit, because the employees give quicker and better work in return, and they do the same amount of work as when working the full ten hours.

At first one might doubt that such radical business methods would pay, but I was particularly impressed with President Patterson's address at the reception, in which he said, "Everything we do *pays*." By considering "everything they do" as a whole, and realizing from personal experience the enthusiastic advertising sure to be done by their visitors, it is not so hard to believe that it does pay. However, a comparison of the twelve or fifteen hands employed during the first year of its existence, only fourteen or fifteen years ago, with the 1,400 or 1,500 in the present institution, is a most convincing argument. Yet every one in Dayton that I conversed with on the subject declared his belief that the N. C. R. pay their employees better wages for the shorter day than the same persons would probably obtain at other places in that locality running ten hours per day.

The N. C. R. might fail to derive some of its benefits from its methods if the same thing became common everywhere, because the public would fail to be impressed by them, the same as a robust man fails to appreciate good health. But if *all* did the same, wouldn't it be as practicable as the prevailing conditions of the present?

To put it all in a nutshell, the N. C. R. recognize the value of healthful conditions, pleasant surroundings, the intelligent performance of work, the loyal support of employees, system, energetic enterprise, that their own ideas are not the only valuable ones, liberal salaries and promotion from the ranks. They seem to be honestly trying to solve the problem of capital and labor, and deserve great credit for what they have done and are doing, especially for the fact that they do not pose as philanthropists, but give the employees credit for appropriate efforts and appreciation in return.

My excuse for dealing, as I have in these notes, with the factory conditions to the total exclusion of shop methods is that I consider such notable exceptions more interesting, and that I expect to have something to say about the N. C. R. shop methods later.

A. L. G.

* * *

Don't use iron filler on castings like steam engine bonnets, throttle valves, and other parts that have to undergo a continual heat from steam. Iron filler is a good and useful thing in the right place; but the right place is not on surfaces that are heated to a very high temperature, since it will crack off in a short time and show with added clearness the irregularity it was intended to cover.

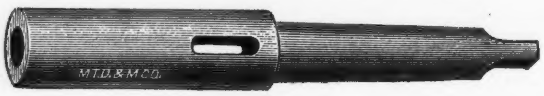
SHOP TALKS WITH YOUNG MECHANICS.—7.

DRILL AND TAP HOLDERS.

W. H. Van Dervoort.

Drivers adapted to the proper holding of drills and taps while in use are quite essential to their long life. Very frequently the shank end of these tools give out while the cutting end remains in good condition. This usually comes from not having the proper holders in which to drive them, but very frequently through the sheer carelessness of the operator.

A mechanic is always annoyed when he finds the drill he wishes to use with the shank mutilated and the tang twisted. Workmen cannot be blamed for not using what their employers will not furnish, yet very frequently they will not use them, or, at best, use them properly when they are provided. A dog tightened into the shank of a taper shank drill, with a bar of iron resting on the shank and under the tail of the dog, will hold the drill from rotating when held against the tail center of the lathe and operating on chucked work. At least it will hold it part of the time, the rest of the time it is slipping under the dog



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screw, which plows up the surface in fine shape. Of course, the operator who would use a taper shank drill in this manner has not the time to smooth up the shank when he finishes with the drill, but leaves it for the other fellow to do. The other fellow is also in a hurry, and jams the drill into the taper, tearing the drill press spindle, growls because it won't run true, and finally when he twists the tang off, declares that taper shank drills are not fit to drill lead with, and all because the taper, due to its roughed condition, not fitted properly in the bearing in the spindle, threw the entire load on the tang, which should not be expected to carry it.

Drills are usually held in sockets or chucks, depending on whether they have taper or straight shanks. As has already been explained in a preceding article, the shanks of taper shank drills are turned to standard tapers. While great refinement is not exercised in producing these tapers, they will be found to vary but little from the exact taper. This is of importance because the socket shown in Fig. 110 should drive the drill not by the

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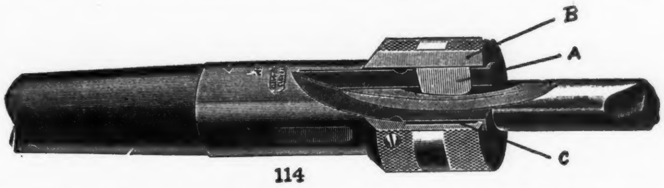
tang alone, but largely by the friction between the surfaces of the shank and training in the socket. For the larger drill sizes under each taper the tang is the weakest part of the drill. Thus the tang of the No. 1 taper on a one-fourth inch drill will break the drill before it will twist, but on a nine-sixteenth-inch drill, which has the same tang, the tang will twist rather than break the drill—that is, assuming that the drills are driven by their tangs alone.

In the socket the tapered bearing should not extend beyond the bottom of the shank or mortise through the shank, and the slot should be but slightly wider than the thickness of the tang. This gives the tang a good bearing well down toward its base. The slot must be sufficiently long to allow the tapered drift or key, shown in Fig. 111, to be inserted over the end of the tang to force the drill out. If the shank or bearing in the socket are jammed, the former will not enter the bearing the proper depth, the tang will catch on the point, the frictional drive between shank and bearing surfaces will be decreased and a twisted or

broken tang will usually result. Frequently, in twisting, the tang will force the drill out of the socket in amount sufficient to allow it to turn in the bearing, the tang cutting out the sides of the slot at the bottom and thus ruining the socket.

When sockets are to be fitted to spindle bearings having other than a Morse taper, they may be obtained with rough shanks, which can be turned to the desired taper. Such a socket is shown in Fig. 112.

When it is desired to bush the bearing in the drill spindle or socket to a smaller size, the bushing or sleeve shown in Fig. 113 is used. It is the same as the socket, except the shank is made



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to envelope the bearing, thus decreasing the length of the connection. Sleeves are not as convenient as sockets when the drill is to be frequently removed, as it is necessary to remove the sleeve before the drill can be forced out. In such cases it is best to bush the spindle bearing to the size larger than the drill taper, and then use a socket for the last reduction.

In Fig. 114 is shown a sectional view of one of several grip sockets that have been placed on the market within the past few years. The object of this socket is to provide a stronger drive for the drill, and thus avoid the twisting of the tang. A key-way is milled in the shank of the drill, into which the key *A* of the socket is forced by rotating the collar *B* through about one-fourth of a revolution. The collar is recessed as shown at *C*, the recess being eccentric to the socket. When the collar is turned so that the deep part of the recess is opposite the key, forcing the drill out crowds the key back out of way. When the key-way is properly milled, the key so fits it that the drive is entirely removed from the tang. This makes


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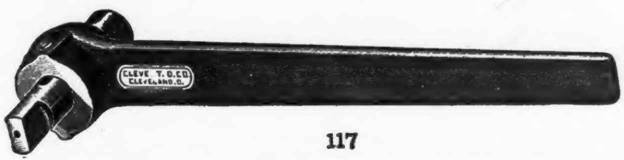
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it possible to use drills which have had their tangs twisted off. This collar and key, when applied to the end of the drill press spindle, will hold the drill from worming into the work and pulling out of the spindle when the point of the drill strikes through. It will also prevent boring bars from pulling out of the bearing when used for under-cutting, a feature appreciated by those who have much of this kind of work to do.

When the taper shank drill is to be used in the lathe for work on chucked pieces, the holder shown in Fig. 115 is excellently adapted. It is virtually a sleeve having a long handle attached, which may be allowed to rest on the carriage of the lathe, the shank end of the drill being steadied on its own center against the tail center of the lathe. Another holder for this purpose is made in which a center in the holder is used rather than the drill center. In Fig. 117 is shown a sleeve holder in which the sleeve is kept from rotating by means of the two screws, which have points turned to fit the slot in the sleeve.

The holder used for driving the Graham grooved shank drill is shown in Fig. 118. It is made in four sizes, holding from 2½-inch drills down to 3-32-inch drills. By means of reducers, one of which is shown in Fig. 119, small drills may be held in the large chucks. These holders are very compact, being but little larger in diameter than the common socket. As the grooves in the drill are cut parallel with each other, taper shank drills may be grooved to fit correctly in these holders, which, as with the socket shown in Fig. 114, makes a good method for reclaiming drills that have lost their tangs.

The above are all positive drive holders, which, in the case of the sudden stopping of the drill will break it if the machine does not stall. To overcome this, numerous friction drive holders have been devised, one of the best being shown in Fig. 120. In this holder the socket *A* is held by friction between the end of the shank *G* and the collar *B*. *F F* are fiber washers between the sliding surfaces, which gives a smooth motion when slipping occurs, and enables the operator to more easily adjust the tool to the proper grip. The collar *C* forms a lock nut to preserve adjustment. The bushing *E*, which carries the drill, fits in *A*, being driven by two keys. In its use the collar *B* is adjusted up until the friction will just nicely drive the drill. This tool, which is made in two sizes, is provided with the necessary bushings for holding drills and taps up to 1¼ inches in diameter. Although bushings for holding the ordinary square shank taps may be had, the tap with special shank, as shown in Fig. 121, is best adopted to use in this holder.

Straight shank drills must be held in in drill chucks, of which there is a large variety on the market. In Figs. 122 and 123 are shown two well-known chucks for this purpose. They are examples of the two general classes, Fig. 122 showing a chuck in which the jaws have a radial motion, and Fig. 123, one in which

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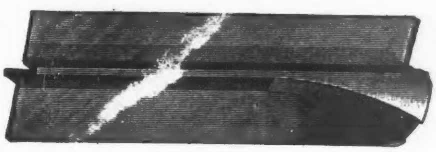
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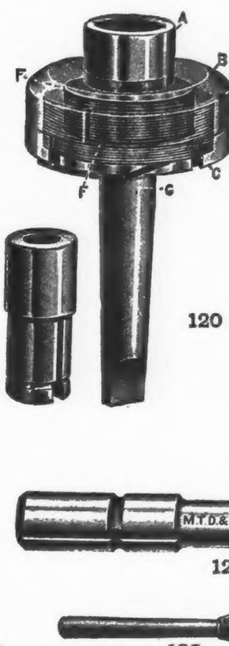
the radial motion is due to another motion along the axis of the chuck. Drill chucks hold the drill by the frictional bite of the jaws upon it. By using a split steel sleeve parallel on the outside and tapered to fit the drill shank on the inside, taper shank drills may be satisfactorily held in the parallel jaws of the drill chuck. Such a sleeve is shown in Fig. 124. In the Pratt chuck, a bar through the chuck has a rectangular hole, which receives the tang of the taper shank drill, thus making a positive drive.

In using drill chucks, it would be well to bear in mind that the keys and spanners furnished with them will grip the jaws suffi-



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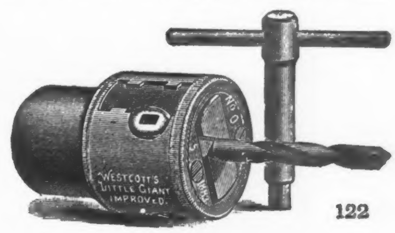

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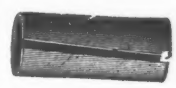
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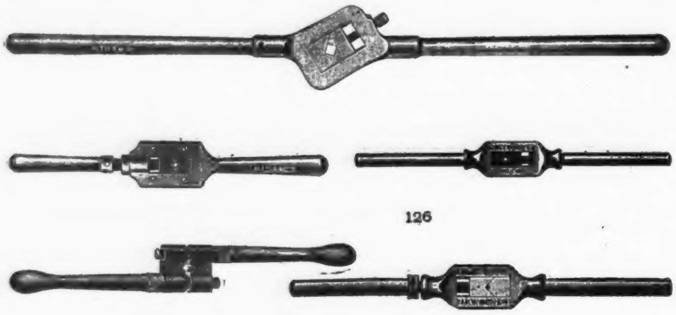
ciently tight upon the drill without the assistance of a 12-inch monkey wrench or 2 feet of gas pipe. Overstraining a chuck destroys its accuracy. Always remove a chuck from the spindle the same as you would a drill or socket—with the drift. Don't feel that because it has a large hub you are expected to knock it out with a hammer.

Before inserting the shank of a drill, socket or chuck in its bearing, wipe both surfaces to free them of oil and dirt, thus making them hold better and preventing injury to the surfaces.

In using the drift, a light upward blow on the underside of the outer end will usually start the drill easier than a heavier blow on the end in the direction of its length.

Tap holders or wrenches are of three general forms—solid, adjustable and friction. The solid tap wrench, an example of which is shown in Fig. 125, is provided with one or more square holes to fit the squares on the end of the taps. The principal objection to the solid tap wrench is that each hole will properly fit but one size of tap shank, thus requiring a number of wrenches to meet general requirements. When more than one hole is made in this wrench, the handles become of unequal length when using any but the central hole, which results in an unbalanced pressure on the opposite sides of the tap, producing a transverse strain, in the resistance of which the tap is weak. Good judgment on the part of the operator will, however, enable him to



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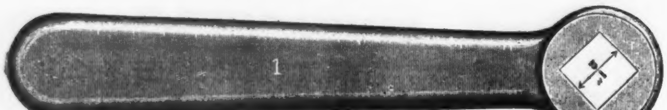
balance these pressures. Again, the tendency is to use these wrenches on taps the squares of which are too small to properly fit in the holes, thus rounding and twisting the tap squares.

In Fig. 126 is shown a group of adjustable tap wrenches, all of which are excellent tools. These wrenches adjust to fit a wide range of sizes, usually taking all sizes, from the smallest to a 1-inch tap. The dies forming the squares are carefully hardened and fitted in the body of the wrench, thus preserving a true square, which fits nicely the square on the tap to which they should be closely adjusted.

Frequently the nature of the work prevents the use of a tap wrench having two handles. In such cases the single handled wrench, shown in Fig. 127, is a good tool. The handle is preferably attached to the shank through a ratchet, which enables the operator to take shorter strokes than would be necessary with the solid end wrench. Sometimes a common monkey wrench is used for this purpose. It should be a good wrench, having square, true jaws, which should be carefully tightened onto the



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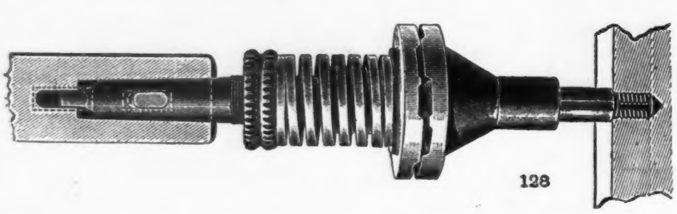


128

tap shank each time the wrench is put on. In using a single-handle tap wrench, the workman must steady the shank with the left hand, so as to offset the side pull on the tap.

Fig. 120 illustrates one form of friction tap holder. Another pattern is shown in Fig. 128. In this holder the upper half of the clutch is keyed to the shank, the lower half turning free on the end of the shank. The jaws of the clutch are beveled on their edges, the spring, which is readily adjusted for tension, holding the halves in contact. When the drive on the top becomes too heavy, the beveled edges force the clutch halves apart, thus allowing the machine spindle to rotate without turning the tap.

Friction tap holders are of great value for machine tapping, and specially so in tapping holes that do not pass clear through the work, as it enables the workman to bottom the tap without danger of breaking it.

METHODS FOR LOCKING CHECK NUTS.

A contributor to Locomotive Engineering, Mr. James McNaught. furnishes to that paper a sketch and description of a simple method of locking a pair of check nuts used to hold air pump pistons on their piston rods. The device can, of course, be used in other places. His explanation is as follows, and will be understood in connection with the sketch in Fig. 1:

"Both of the nuts have milled in their adjacent faces grooves 1/16 inch deep and ⅛ inch across from each hexagon side. A ⅛-inch hole is drilled through the piston rod, directly in line

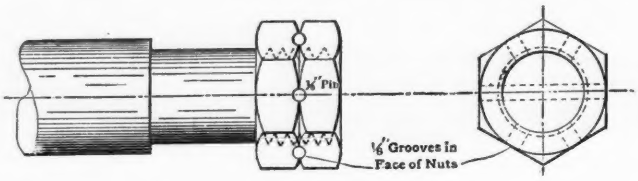


FIG. 1.

with the junction of the two nuts. It will be seen that when the inner nut is screwed tightly against the piston head, and the jamb nut set up, the grooves in their inner faces may be made to coincide with each other and one coincident pair with the pin hole in the rod, so as to allow the insertion of a steel pin, which, it is evident, will prevent either nut turning. The grooves being cut across from all sides of the nuts, it requires but slight movement to turn the holes in line. The nuts are screwed on a mandrel and grooved with a milling machine cutter, as the grooves require to be perfectly central with the thread."

For drilling the hole in the rod, Mr. McNaught suggests a jig which will slip on over the end of the rod in place of the piston, and having an internal thread to fit the threaded end of the rod. A hole is drilled through this piece to guide the drill.

In connection with this subject attention may be called to another method of keeping nuts from working loose, which is at once simple and cheap, and which can be used almost anywhere

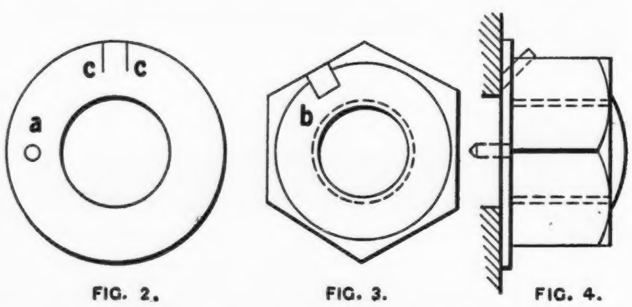


FIG. 2. FIG. 3. FIG. 4.

where the appearance is not the first consideration. It is often applicable to piston rod nuts. The essential feature of the device is a washer, shown in Fig. 2, cut out of sheet metal of soft quality, and of the right size to go with the nut with which it is to be used. In Fig. 3 is shown the under side of the nut, having a slot, b, cut or champfered in one side, across the lower edge of the nut. In using the washer, it goes under the nut and must be kept from turning by a pin or screw in the hole, a, Fig. 2, or by other means. After the washer is fastened in place, the nut is set up against it and two marks, cc, Fig. 2, are scribed on the washer through the slot that was cut out at the back of the nut. The nut is then taken off, the washer cut with a cold chisel on the marks, cc, and then the washer and nut are put back in place again, until the slot in the nut comes opposite the cuts in the washer. Finally, to hold the nut in place, the portion of the washer between the two cuts is bent over into the slot. Several modifications of this washer method are possible and almost any of them are reliable.

* * *

The propelling engines for the new torpedo boat destroyers are to be of 4,000 HP. each, a pair of engines to be used in each boat. When it is remembered that the engines of the "Maine," that we illustrated some time ago, were of 9,000 HP. each, or only about double that of the destroyers' engines, it can be appreciated what an enormous power will be required to drive even these small craft at the speed of 25 or 30 knots that they will probably make.

ANOTHER REPAIR JOB.

C. E. Mink

Shortly after repairing the fly-wheels, as described in the April number of Machinery, I discovered what promised to be a source of trouble in the No. 2 engine. It will be remembered that there were two blast furnace engines, both of the same type, having built-up fly-wheels, with the crank-pin bosses cast on the hub of each wheel, as shown in Fig. 1, which represents the hub and gives the relative positions of the shaft and crank-pin. The stroke of the engines was six feet.

The trouble which developed was a crack in the face of the boss, starting at the edge of the hole in which the crank-pin was fitted and running upward toward where the boss was rounded over. I made a mark at the end of the crack with a fine cape chisel and watched it every day, and soon saw that it was passing the mark. It was clear that something must be done at once.

It happened that the crank-pin boss projected an inch from the face of the wheel hub, and that there was a recess in the face of the hub about two feet in diameter, I think, in which was shrunk or pressed a wrought iron band to strengthen the hub around the shaft. This band was turned true and projected 1¼ inches from the face of the hub, so a band could be put around these two projections by simply chipping and filing around the upper half of the crank-pin boss so as to make a good bearing there for the band.

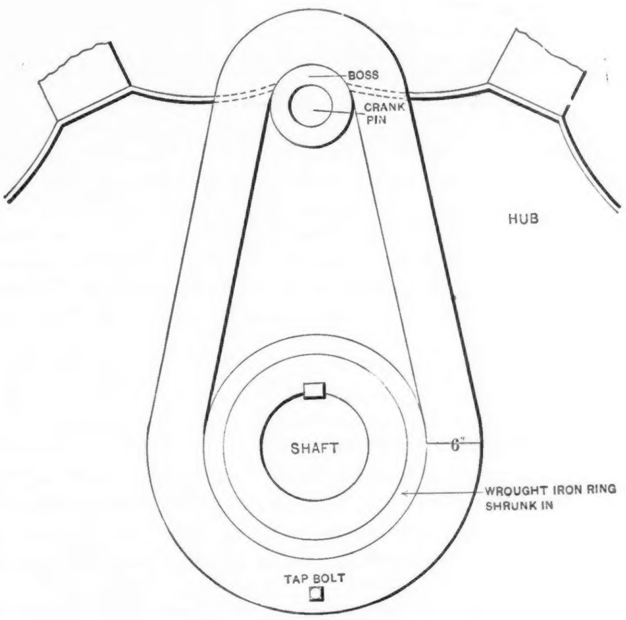


FIG. 1.

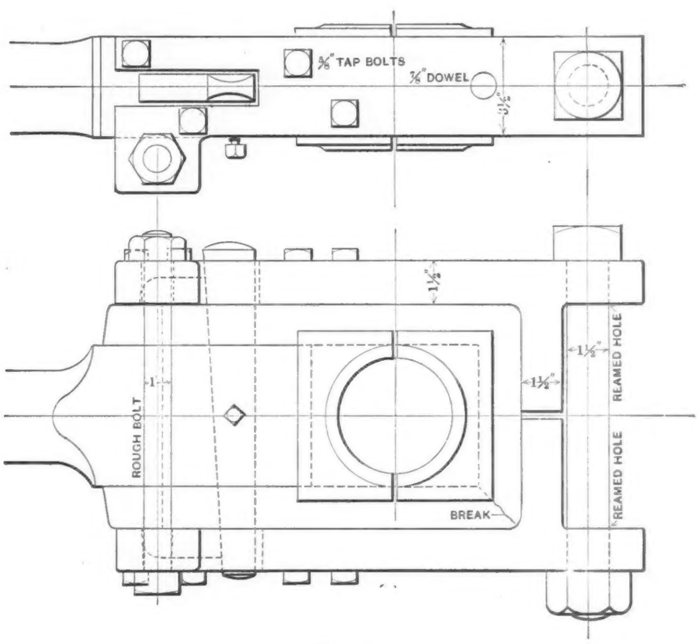


FIG. 2.

At every cast the crosshead was propped up, the connecting rod disconnected and fastened one side, and the work on the boss continued as long as the engine could be permitted to stand still. In the meantime the band was being made 1 inch by 6 inches, turned edgewise. The edge intended to fit around the crank-pin boss was dovetailed to fit the boss, which was cut with the same dovetail. This was done to prevent the band from drawing off the boss when shrunk on. A hole for a ¾-inch tap bolt was drilled in the large end of the band and a hole drilled and tapped in the hub to admit a tap bolt to prevent the large end of the band from drawing off the projection of the wrought band shrunk in the hub.

The band was heated in a wood fire in front of the engine room, and when it was put on, a stop of about two hours was required. The band closed the crack, which never showed again. Fig. 1 shows in a general way the construction of the band and its position when shrunk on.

A BAD SCRAPE.

But the quickest way out of a bad scrape, however, that it was ever my good luck to plan, was the case of a broken connecting rod strap on the engine with the banded fly-wheels. The strap which broke was on the crank end and the break occurred at one of the lower corners, as shown in Fig. 2.

The method of making the repair will be clear by reference to the sketch. The break happened at 9 o'clock in the morning, and as it was three miles to the machine shop I propped up the crosshead, took off the strap and put it in a buggy and started, doing my planning on the way. It would not do to weld the strap, as that would spoil its fit on the rod end; and to forge and plane up a new one would stop the engine too long. A blowing engine for a blast furnace must be kept going at all hazards.

In looking the job over afterward I think the best plan that I could have used was the one adopted. Two heavy straps were forged, as shown in the sketch. The projections under the end of the broken straps were made strong enough to sustain the pull on the up stroke, and, being forged in two separate pieces, they could easily be made a perfect fit to the strap, so as to dispense with planing. A 1½-inch bolt held the straps, forgings and boxes to their proper places. The gib and key held the upper end of the strap to its natural place and the forged pieces were so made as to permit that to be done. The forgings were bolted to the old strap by four ⅝-inch tap bolts, which were a fit in the forged straps, and a ⅞-inch dowel pin was also put in to assist the tap bolts in holding the pull. Lugs were forged on the upper edge of the straps for a bolt to hold this end of the straps tight to the connecting rod end. This bolt was not turned and passed easily through the holes in the lugs, its strain being simply tensile. The other bolts and the dowel were all fitted to reamed holes while the straps were being forged and the holes drilled and tapped in the broken strap. When the forging of the new straps was completed they were clamped to the broken strap, the tapping drill was run through and the holes in the forged straps drilled out and reamed. Finally the 1½-inch hole was drilled and reamed, that bolt being a drive fit. The forgings were made by the same Isaac Tebow of Syracuse who did the other work for me, and who was able to forge anything possible.

It was a quick way out of a bad trouble. The projections which held up the broken end of the strap not coming together enabled the fits to be made entirely by forging and permitted the old strap to be drawn up tight to its place on the stub end.

* * *

We, who are accustomed to micrometer measurements in every-day shop practice, are inclined to look upon bridge building as a course and crude kind of work that requires no particular accuracy. The "Engineering News," however, contends that the accuracy attained in bridge work is relatively of a high order. As an instance of good workmanship it calls attention to the new steel bridge recently completed across the Schuylkill, at Philadelphia, and says that in a structure of this magnitude, where each arch differed in all its members, and without any previous assembling of the different parts, every joint and detail was found to fit perfectly upon erection, speaks marvels for the perfectness of the shop management and machine work of the modern bridge shop. It is also stated that the 840-foot steel arch that replaced the old footway bridge across Niagara came together at the center within ¼ of an inch of the calculated distance.

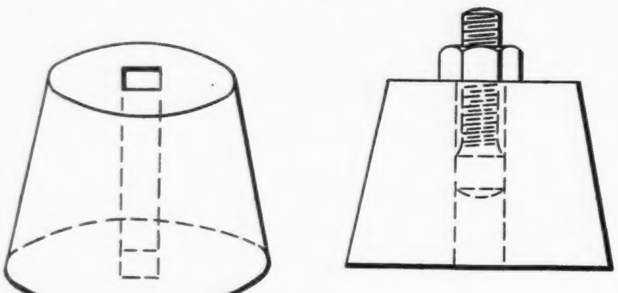
WHAT MECHANICS THINK.

A DEPARTMENT FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE.

Write on one side of the paper only, and when sketches are necessary, send them. No matter how rough the sketches may be, we will see that they are properly reproduced.

A PLANER JACK—TEMPERING CHISELS.

A handy little jack-screw for a planer can be made by using a casting having a square hole cored in it just large enough to take the head of a ⅜-inch set screw, as shown in the accompanying sketch, then by dropping in a set screw, head down, with a nut on it, as indicated in the second part of the figure, the work can be raised or lowered by turning the nut.



Here is also another point—about tempering chisels. An expert on tools says that the best way to get the right temper for a chisel which is to be used on steel is to temper it first as you think about right. Then lay it across the corner of the anvil and hammer the point, breaking it as often as it will break, and then, when you can break it no more, grind it, and that will be the best temper to hold its edge and not break.

Toronto, Ont. W. J. Thompson.

A FEW "MUCKETS."

One of the men in the testing room of our shop was adjusting a safety valve the other day, and in doing so his hand was for a moment enveloped in steam; he was noticed to jerk it away suddenly, with an exclamation more expressive than elegant. On being asked if he was scalded he said "No," but wanted to know what shocked him. As there were no electric wires within several hundred feet of the place the other men laughed at him, but the writer having witnessed the episode suddenly remembered that the friction of escaping steam generates high potential or "static" electricity, and that some time between 1850 and 1860 a machine was built for extracting (?) the "Hydro-Electricity" from escaping steam, that experiments were made to learn the best form for the escape pipe, and that the one finally adopted was like this, a great number of small diameter in rows with insulated pointed wires, one or two inches above the pipes, to complete the circuit. Dry steam alone would generate a current.

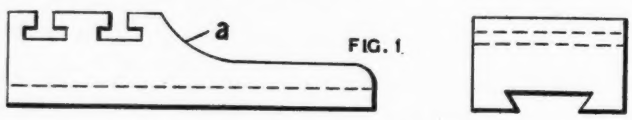
A good "mucket," rather old and probably well known, was made use of some time ago. One of the men was sent alone to do an urgent repair job some distance away from the shop; knowing what was to be done, he took the necessary tools, but he came across a hole, which had to be tapped a sixty-fourth larger than his tap. Instead of going back to the shop and losing half a day he flattened a piece of copper wire, heating it to keep it soft, until it became a sheet 1-64 inch thick; then he bent it around half of the circumference of the tap, then tapped out the hole to size, the two free cutting edges of the tap doing the work, while the copper acted as a distance piece on the other two edges.

A cast iron roller 4½ inches diameter and 5 inches long had inserted in the center of its circumferential length twenty hemispherical teeth of 7-16 inch round steel, projecting 7-16 inch above the surface and ⅝ inch in the iron. To pull them out was impossible, and the only other way seemed to be to turn them down to the surface and drill them out. A happy suggestion from an old mechanic, though it in itself failed, was, to heat them in a forge fire and then the teeth could be jarred out. It was done, but they were driven in so tightly that jarring did not move them. As the roller was wanted in a hurry the next thing to do was to turn them off and drill them out; and to do that as soon as possible the red hot roller was dropped in water. Upon removing it what was our surprise to find that one half the teeth had been completely removed from their holes by some unknown force; a second heating and cooling removed all but one, and a third heating and cooling completed the job. Then the roller was put in a lathe to be turned off, but the "mushet" tool would not cut it, and the roller had to be heated and slowly cooled before a tool would touch it. A reason for the teeth being forced out is now in order, as they were a very tight fit in the holes, and it would be well nigh impossible for water to get behind the teeth and force them from their holes. If the teeth had been only loosened then the matter would not have been surprising; but the fact that they were forced clear out of their holes, and some of them half a foot away, signifies that quite a little power was employed. Jos. B. Hall.

Auburn, N. Y.

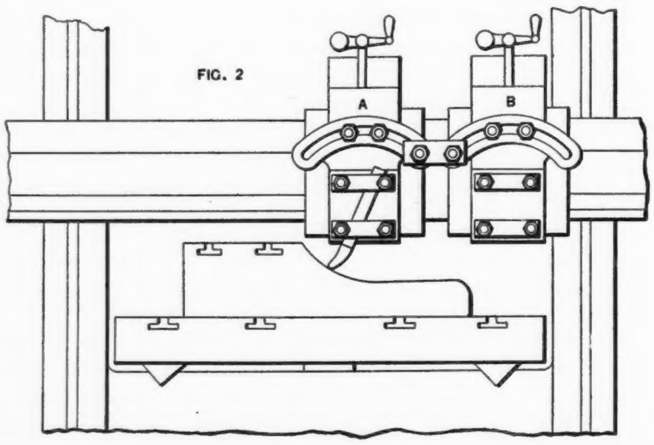
A CURVE PLANING FIXTURE—GRADUATING DEVICE.

While working in a large tool shop in Philadelphia I saw a job of planer work done by one of those tramp machinists which almost took the boys' breath away for a minute until they saw how nicely it worked. The tramp (I will call him Frank) was literally full of such kinks. They were building at that time some 63-inch lathes with a tool slide something like the sketch, Fig. 1. The curve at a had a radius of about 7 inches. Frank got four of these slides to plane, and, of course, the boys all



smiled at the nice job he would have tooling the curve out by hand. The slides were all to be filed and polished after planing. Frank said nothing, but worked all the slides up to such a point that he could lay them up side by side and plane the curves all at once.

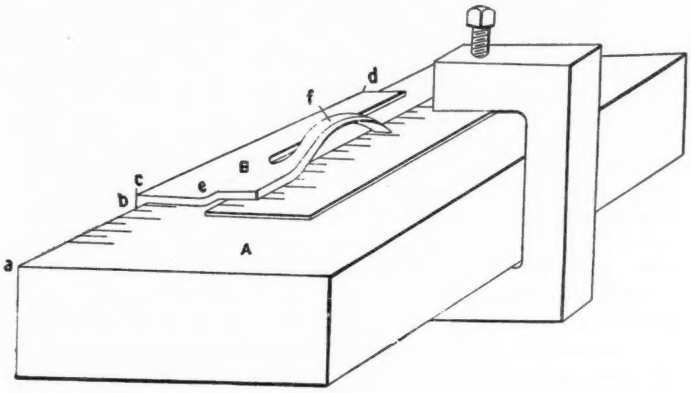
He then brought the two heads on the cross-rail in position, as shown in Fig. 2. Head A was clamped to the rail, but the apron was allowed to swivel and the tool was set so as to describe just the right curve on the lathe tool slide, which was placed on the planer table. This setting was easily done by first laying out the curve on the slide, thus giving a line to set to.



Head B was not fastened to the rail, but the apron holders of the two heads were connected by a strip of iron, as shown in the sketch. The cross-feed for head B was thrown in, but not for head A, and the tool therefore followed around the curve of the lathe tool-slide under the action of the power feed. Frank put a spiral spring under one of the clamping nuts of the apron on head A so as to prevent the tool from slipping too far ahead.

Another handy device Frank had for graduating boring mill and planer slides is shown below. A is the piece to be graduated along the edge a b. To accomplish this a steel scale is

clamped to the piece to be graduated by means of the gripe, as shown, and a gauging slide, B, is made to transfer the spacing as given by the marks on the scale to piece A. The gauging slide is made of a piece of spring or tool steel, that can be tempered. The further edge from c to d is bent over at right angles, thus forming a guiding edge when sliding the piece along. The part f



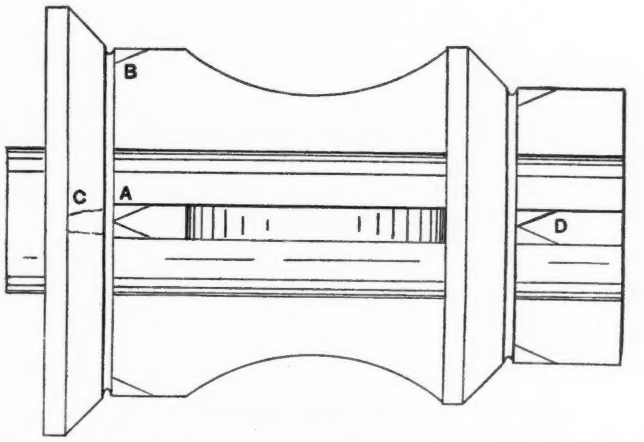
is spring tempered and is drawn down thin at the point, so that as it is moved along, this thin edge will snap into the succeeding marks on the scale. The edge, c e, is taken as a guide for a scriber. I think this brief explanation, together with the sketch, will be sufficient to make the device, and its method of working, clear. E. H. YEAKEL.

Bridgeton, N. J.

THROTTLE VALVES.

It is well known that the throttles of locomotives are rather difficult to keep tight, as they are subjected to a variety of trying conditions.

The form of valve shown in Fig. 1 is in common use and is partially balanced, being subjected to boiler pressure at the opposite ends. Thus, if the diameter of the upper seat is 5 inches, its area is $5^2 \times .7854 = 19{,}635$ square inches, and if the diameter of the lower seat is 4 inches, its area is $4^2 \times .7854 = 12.566$ square inches, so that the effective area that resists lifting the valve is only $19.635 - 12.566 = 7.069$ square inches.



While this simple expedient results in an easy working valve of large capacity, the two seats present difficulties in getting and keeping their surfaces at the same distance apart as those of the throttle box. Another trouble is the effect of the steam eddies around the edges of the wings if they are left square. The invariable result is that a groove is cut through the seat as shown at C. It has been the practice on the Fall Brook Railway for years to chamfer off the ends of these wings, as shown at A, B and D, thereby completely overcoming this trouble. With this difficulty removed the two seats appear to wear down at the same rate, so that comparatively little trouble is experienced with leaky throttles. FRED E. ROGERS.

Corning, N. Y.

CUTTING SPEEDS.

Here is a clipping from some mechanical paper that a man handed to me. He said the Old Man gave it to him one day when he was feeling rather sore, with the remark that, "The profits of the whole shop for the next ten years wouldn't be enough to buy a fly a paper collar if the men were permitted to run their machines according to their own ideas of speeds and feeds."

" Speed of milling cutter for cast iron equals the constant 200 ÷ by diameter of cutter, or faster."

" Feed = .6 inch to 1.5 inch per minute."

" Speed of drills in wrought or cast iron:

" 1/8 inch	= 2,300	revolutions per minute.	
" 1/4 "	= 1,100	" " "	
" 3/8 "	= 550	" " "	
" 1/2 "	= 450	" " "	
" 3/4 "	= 350	" " "	
" 1 "	= 200	" " "	"

There has been a good deal written about this matter of cutting speeds, but I think this piece comes about as near to being practical in the ordinary shop as anything that I have seen. Some of the writers speak of feeds of 4 inches per minute. and that may be all right in some cases. But in the ordinary run of work, how many times will you get pieces that are strong enough to stand the strain of such cuts, and give good results? Even if the pieces are strong enough to stand it, how many times will you find suitable fixtures for holding them provided in a shop like this? You might as well glue a piece on a mosquito's back and try to mill it as to fasten it on to some of the fixtures we have that are about as weak-kneed as a mosquito. I took pains to note what my machine was doing when I was given the piece of paper, and found that the feed was just a little better than half way between those limits.

And here is another thing: There is a little upright drill in our shop, a brand new one that the Old Man bought and set up himself about two weeks ago. The largest drill that it will take is 1/4 inch, and I will wager ten dollars that its highest speed is not one-half as fast as given in the table that he recommends for that size drill.

A. HARDCASE.

A TWO-FOOT RULE FOR FIGURING OUT SCREW CUTTING.

The readers of MACHINERY, especially the apprentice boys, will find the following thread cutting rule simple and easy to understand. There are a variety of rules, but some are either hard to understand because they are not explained in shop talk, or else the figuring is too hard. The following rule is all figured on a common two-foot ruler, which all shop men have handy.

For our first example we will take a simple lathe that cuts its own lead screw with even gears. We will say it has a lead screw that is four-pitch and we want to cut a ten-pitch thread. We take our ruler, place our thumb on the first inch and say "ten threads to one inch, twenty threads to two inches, thirty threads to three inches, forty threads to four inches." Here we will stop at four inches, and by multiplying the number of inches on the ruler (which is four) by the number of threads to be cut we have as follows: $10 \times 4 = 40$ for one gear. Then we multiply the number of inches on the ruler again (which is four) by the number of threads on the lead screw, which is four-pitch, so we have $4 \times 4 = 16$ for the other gear. So 16 and 40 will cut ten threads.

If these gears cannot be found keep adding inches until the proper gears are found. For example, we will say that we cannot find 16 and 40 gears, so we will move up to twelve inches and we again have the number of inches on rule multiplied by thread to be cut, which is ten.

Example: $10 \times 12 = 120$ and number of threads on lead screw (which is four) multiplied by number of inches on ruler, we have $4 \times 12 = 48$; consequently 48 and 120 gears will cut ten-pitch, and so on.

Now suppose we have a fractional thread to be cut, say five-and-a-half-pitch. We again use our ruler as before, but a little differently. Placing our thumb on the first inch, we will say there are five and a half threads to one inch—eleven threads to two inches; here we change the fraction five and a half to whole number, eleven; always change the fraction to a whole number. We now have a whole number at two inches, so slip to four inches and have twenty-two threads. We will stop here (but if gears cannot be found, keep on; thus, by goingto six inches, we have thirty-three, to eight inches, forty-four, and so on). By going back to four inches, we have twenty-two threads, multi-

plied by number of inches on rule, which is four, and which gives $4 \times 22 = 88$ for one gear, and lead screw, which is four, multiplied by four inches on ruler, gives $4 \times 4 = 16$, so we have 88 and 16 gears to cut the five-and-a-half thread.

Worm threads may be cut the same way.

Example: Suppose we want to cut one thread in three-quarters of an inch, two in one and a half inches, three in two and a quarter inches and four threads in three inches. Always change to a whole number and slip as many inches, so as to keep it a whole number. Therefore, we will go to six inches. We have eight threads here, and so will stop and proceed as before. We have gone to six inches and have eight threads; by calling this an eight-gear and number of inches, which is six, multiplied by four, gives a twenty-four gear; so a twenty-four-gear and an eight-gear will cut one thread to three-quarters of an inch.

This rule will answer for a simple lathe—that is, a lathe whose stud makes one complete revolution the same time the spindle does.

When we find a lathe geared up so the spindle makes two revolutions to one revolution of the spindle, we proceed thus:

Example: Lathe has a lead screw six-pitch. Then to cut six-pitch we will go to five inches on ruler, and we have five the number of inches on ruler, multiplied by thread to be cut, which is six, which gives thirty—this for one gear. Then the number of inches, which is five, multiplied by number of threads on the lead screw, which is six, gives thirty. As this lathe has its spindle turned twice while the stud turns once, we will have to double the last gear, which gives $2 \times 30 = 60$; so sixty and thirty gears will cut six threads, and we add on thirty to all the last gears.

We will take another example of the same kind on the same kind of lathe.

Example: To cut eight threads, we will go to seven inches on ruler. We have $8 \times 7 = 56$ for one gear and $7 \times 6 = 42$; and adding on thirty, we have $42 + 30 = 72$, so seventy-two and fifty-six will cut eight threads. Always add to fractions and worm-threads the same way.

We will now take a Flather lathe with lead screw six-pitch. I look on index and find that forty-eight and thirty-six will cut six threads, so subtracting thirty-six from forty-eight, I have twelve to add on, as follows: I want to cut seven threads on this lathe, so I use my ruler as before and proceed the same as figuring on a simple lathe; by going to to six inches on ruler we have $6 \times 7 = 42$ for one gear, inches on ruler, which is six times thread on lead screw, which is six, we have for result $6 \times 6 = 36$, and adding on twelve, we have 48, so forty-eight and forty-two will cut six-thread. The difference in lathes can be easily found, if there is no index, by trying on equal gears, and by trying them to see if they will cut the same pitch as lead screw. If not, try two gears that will drive one into the other one and a quarter times. If these don't work, try one and a half or two.

Example: Thirty-six into forty-eight gives one and one-fourth turns, or by trying again, we will say fifty-six into 112 gives two, and so on until proper gears are found.

W. C. Hensley.

MANUAL LABOR AND SCHOOLS.

It is a point gained when one has learned to use the hand in an intelligent way. Such an acquisition not only enhances the value of the work done, but it helps to maintain and increase that kind of interest in one's work, without which it is apt to become mere drudgery and slavery. To keep alive such interest is therefore one of the main problems of our time, and many remedies have again and again been suggested in order to effect this. One of these remedies is, that the school should come to the aid of the masters and workmen, and take upon it the duty that formerly devolved, though, of course, less scientifically, upon the masters under the old apprenticeship system. It is not sought thereby that the school be transformed into a mere shop, and asked to teach the principles that lie at the base of all true and successful trade work. The demand, rather, is, that while bestowing a fair share of attention upon what is now generally taught in most of our grammar and high schools, it should not overlook the altered condition of things, and the fact that at least seven-tenths of the youth that are now being educated in our towns and villages must eventually find their livelihood in manual work.

The suggestion is surely fair and sensible. Is it not true that a great deal of the teaching at present imparted is utterly useless and lost, and that many of our boys and girls, on leaving school, are not by any means so well prepared as they might otherwise be for the part they must take in the future struggle for maintenance?

It cannot be too often reiterated, of course, in making the suggestion, that it is not desired that the school be turned into a mere shop. Behind the training of the hand there must always be the discipline of the brain and of the head. Manual labor and thought must be taught to accompany each other, and it is just here that the idea of engaging the interest of those thus taught in their work comes in, and proves of countless service to all concerned. The subject is certainly one of wide and increasing value.

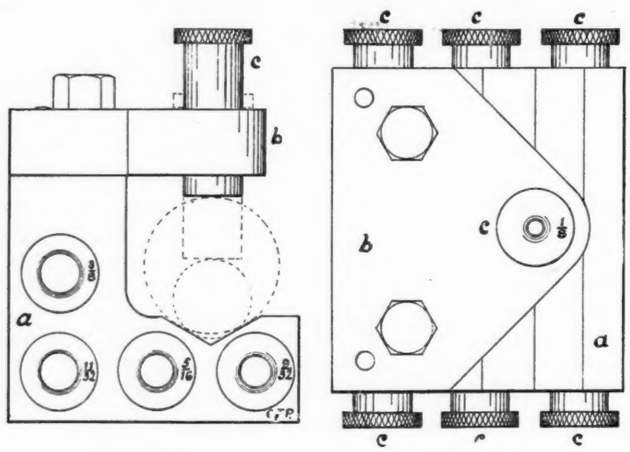
James Wilson.

Torrington, Conn.

JIG FOR DRILLING SHAFTS.

Have you ever tried to drill a small hole through a small shaft or piece of round finished work, and find how difficult it is to strike the center, even with an ordinary V-block to support the shaft and a lot of sighting and testing and squaring of the work?

I have, and find a big time saver in the little jig I here illustrate:



END VIEW. TOP VIEW.

A is the V-block, in which I have provided holes to receive a set of eight bushings or drill pilots ranging from one-eighth to three-eighths by thirty-seconds. *B* is a plate screwed and doweled to the V-block, so as to support the bushings accurately over the center of the V. The bushings *c* can be either a neat sliding fit in *b*, or can be threaded, in which event the work can be clamped by screwing the bushing down upon it.

As illustrated, I have had very satisfactory results by holding the work in the hand while drilling. I have made the angle of the V about 30 degrees, as it made a shorter bushing serve to reach a small diameter, and seemed to answer the purpose just as well as an angle of greater depth.

C. F. P.

Cincinnati, O.

TO MARK TOOLS.

As there have been some questions asked about marking tools with acid, I enclose a receipt which will mark any kind of tools, and which will not burn the hands or spoil anything except metal, while doing the work better than any acid I ever used. It can also be made at about one-tenth the cost of the acid. I bought this receipt of a chemist:

Take 16 ounces of distilled water and in it dissolve the following: 4 ounces of sulphate copper, 4 ounces chloride soda, 1 drachm sulphate zinc and ½ drachm sulphate alum. After it is dissolved it will be ready for use. Take the tool that you wish to mark and cover the place to be marked with a coating of soap (any good soap will do). Then write the name, marking with a pencil or other sharp instrument, and cover the place with the solution, or, rather, fill the marks made by the pencil, using the fingers, if you want to. Let stand for a little while, and when the name gets copper colored, wet and rub off. The soap is simply rubbed on the tool until there is a good coating. This solution needs to be on the tool only about one or two minutes.

Columbiana, O. F. H. G.

THREADED ARBORS.

The arbor and cutter illustrated and described on page 83 of the August number of MACHINERY is apparently new to your correspondent, and may be to many of your readers, so it may be of interest to know that it has been in practical use in the Brown & Sharpe Works, in Providence, for the past twenty years or more. In fact, no one can now remember the time of its introduction, but can trace it back for that length of time.

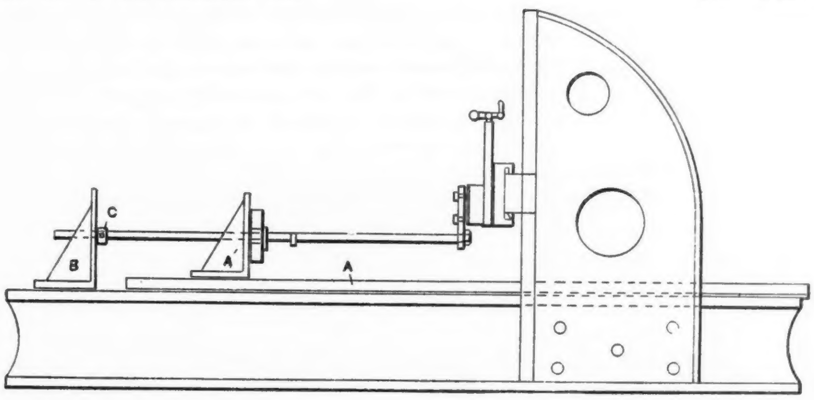
It is essential that the arbor should be made with the thread corresponding to the teeth of the cutter—that is, for a right-hand cutter the thread on the arbor should be right-hand to prevent the cutter from unscrewing from the arbor when in operation; and for a left-hand cutter the thread on the arbor should be left-hand, for the same reason. The novice is somewhat puzzled to determine whether a cutter is left or right-hand, and it is a point that has been in controversy among some who are not novices. As the name is taken from the direction in which the cutter runs when in operation, it is a safe rule to remember that the ordinary drills and reamers are right-hand cuts, so that a milling cutter running in the same direction when cutting would be right-hand, and when running in the opposite direction left-hand.

Ordinary milling cutters with straight holes may be put on the arbor to run in either direction. This is not so with cutters with threaded holes, for when put on properly the cutting has a tendency to screw them up tighter, while if put on wrong the opposite is the effect, with sometimes disastrous results.

Providence, R. I. D. D. DONOVAN.

A PLANER USED FOR KEYSEATING.

Some years ago, having keyways to cut in 100 spur and bevel gears, and not having a keyseating machine or slotter in our equipment, I cut them economically on a planer by the method described. While the idea is old, it may be of benefit to some of your readers. An angle plate is bolted to the planer table *A* to support the gears to be planed. Stop pins are fastened on the face of the angle plate to facilitate setting the gears. *B* represents an angle plate bolted to the shears of the planer. Two small angles, drilled and tapped for set screws, are fastened to the face of angle plate *B* at *C*, and between them is a bushing pivoted on the points of the two set screws, which serves to steady the end of the extension bar.



Feeding the head of the planer down gives the depth of the keyway, and the bushing accommodates itself to the angle of the bar on the pivot points of the set screws. While one angle has to be removed to put a gear on the bar, or else the bar removed, I still found this an economical way to plane the keyseats in quantities. JAMES T. FINK.

Washington, D. C.

A PATTERN-MAKER'S SLIDE REST.

There have already been so many ideas advanced for the improvement of the machinist's lathe, that a neutral observer cannot help soliloquizing as to whether it is not falling heir to an unusual amount of partiality when the attention given to it is compared to that bestowed upon its brother, the pattern maker's lathe. This machine really demands the study and ingenuity of the machinist as much as the tools that the pattern maker uses for turning wood require his skill.

A clever machinist has allotted part of his ingenuity in the direction of designing a tool for the pattern maker, which is shown in the following sketches. The similarity to the tools for his own use is readily seen. But nevertheless it gives the pattern maker a very useful tool as well, and one with which he is enabled to trim and face all kinds of straight work as true as with an engine lathe; and by the addition of a swivel to the cross-slide he could turn outside and inside bevels, tapers, etc.

Fig. 1 is an end view of the attachment; Fig. 2 is a side view; Fig. 3 is a plan showing the lathe shears, and the slide *B* with the cross-slide *c* removed.

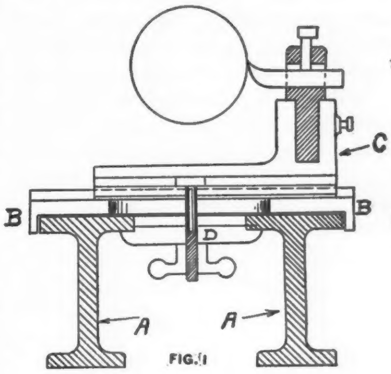


FIG. 1

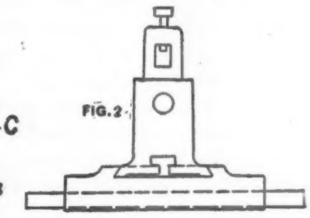


FIG. 2

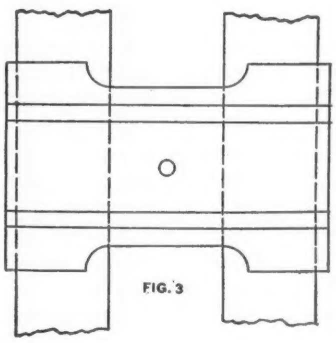


FIG. 3

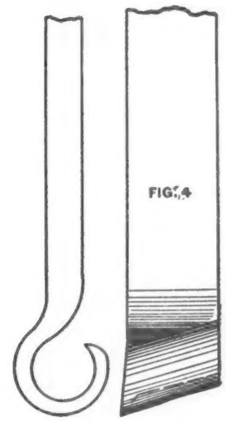


FIG. 4

A represents the lathe shears; *B* the slide-rest, fitted on the ways to slide easily; *C* the T-rest and tool holder, sliding across the lathe on *B*. By inserting a block between the clamp *D* and the rest *B*, *C* is, of course, held firm for turning straight work, and *B* at the same time is allowed to slide (by hand) on the lathe shears *A*.

A suitable tool for general use in connection with the foregoing side-rest, is shown at Fig. 4, and needs no further explanation.

GEO. H. WALTMAN.

Hokendauqua, Pa.

MORE ABOUT PITCH.

Mr. L S. Levy, in the August issue, takes exception to my definitions of diametral pitch, contending that it should be defined as "that fraction of the diameter that the circular pitch is of the circumference."

When diametral pitch was first introduced, it was but natural that an attempt should have been made to make diametral pitch bear the same relation to the diameter that circular pitch bears to the circumference. It is equally natural, however, that, after a little experience in the shop, this definition should be quite generally dropped, as admitted by Mr. Levy, in favor of the more useful definition of "Number of teeth to each inch of diameter."

To me this definition seems quite as logical as the other one. Diametral pitch was devised to meet the needs of the shop, and if teeth were still laid out in the drawing room and made in the pattern shop and foundry, we would still be using the older circular pitch. Diametral pitch was adopted for the purpose of taking the place of circular pitch, and I can see no reason why there should be any attempt to associate the two, as far as their definitions are concerned, when, as I believe, it is more convenient to do otherwise. There is nothing illogical in defining diametral pitch as a ratio, and as the ratio of the number of teeth to the diameter, which is virtually what my definition amounts to.

As far as books and authorities are concerned, while Unwin's "Machine Design" is, of course, a standard work, it certainly is not one that I should take to be representative of modern American shop practice on subjects like gearing. As opposed to it, I

will name a modern American work, which I own, Stahl and Woods' "Mechanism," and as opposed to MacCord's work, which is mentioned, I will name Grant's "Teeth of Gears." Both of these gives the definition that Mr. Levy condemns. Where authorities disagree, therefore, it is clearly evident that there is room for an honest difference of opinion.

One other point, regarding "self-made engineers," etc., concerning whom some rather uncomplimentary reflections were implied, at least. The only kind of engineer that is worth anything is, in a sense, the self-made engineer. You cannot pump engineering into a man. He must seek it himself, whether he is in the shop or in college, and because a boy has passed all his examinations at college, that does not make an engineer of him, if he lacks the engineering instinct, any more than will several years in the shop. Mechanical men must be judged by the knowledge which they have and by what they are able to do—not by where or how that knowledge was obtained. This in behalf of some of my fellow workers, whose hands and minds I know to be well trained in ways mechanical. FOREMAN.

Cincinnati, O.

FATAL IN OTHER WAYS.

PROVIDENCE, R. I., Aug. 8, 1898.

Editor MACHINERY:

Our attention has just been called to page 328 of your issue of June, 1898, in which appears a communication from Wm. F. Torrey, of Medford Hillside, Mass., under the heading, "That Fatal Pin." Mr. Torrey illustrates a device, of which he made the drawings from sketches and suggestions of the writer, for overcoming a defect in the details of stop motions for governors. This device was an invention of the writer, and he now holds letters patent for same. Mr. Torrey's connection with the device was simply that of a draftsman carrying out the instructions of his superior officer. As Mr. Torrey's communication conveys the impression that this device can be used by any one, we desire to dissipate this impression, and would say that our rights in the matter will be fully protected. Yours truly,

RICE & SARGENT ENGINE CO.,
Richard H. Rice, Treasurer.

A CHUCK PROBLEM.

As some of the readers of MACHINERY seem to like the solving of practical shop problems, the following mechanical nut may be worth cracking:

It is evident that the lessons learned by experience are the most valuable, and a problem worked and understood is generally worth more than pages of elaborately worked-out matter than can be skimmed over and dimly understood.

This one takes in a little of lines and angles, and some may think it savors of geometry, but the rules of arithmetic are sufficient for its solution.

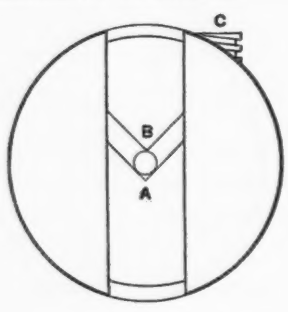


FIG. 1.

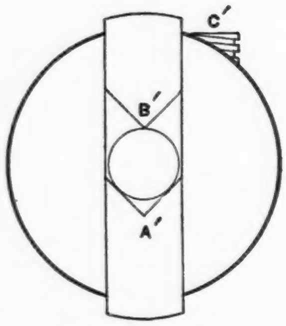


FIG. 2.

A drill chuck is on the market which has salient and re-entering angled jaws, as shown in Figs. 1 and 2. These angles *A* and *B* are supposed to be right-angled or square. Now, of course, the different sized drills are to be gripped so that their axes or center lines shall coincide with that of the chuck. It is evident that the two jaws cannot move outward at the same speed from the center, as is clearly shown in Fig. 2. Here the point of jaw *B′* is only one-half the diameter of the drill from the center, while the corresponding angle *A′* is removed considerably more than one-half the diameter of the drill. The jaws are moved by the right and left hand screw *C*, and we want the ratio of the pitches of the two threads. The left-hand thread of *C* is engaged with the jaw *B* and is 10 pitch. What pitch is the right-hand thread, and what is the most practical compound combination of gears for cutting it in a lathe having a lead screw of 4 pitch? FRED E. ROGERS.

"THE PRINCIPLES OF BELTING."

I am inclined to offer some friendly criticism on the paper in August MACHINERY, headed as above, and especially so as it is addressed to young mechanics. Those who write for that class of readers, more than any other, ought not to write anything in the line of mechanical information that cannot be sworn by. They ought also, for very obvious reasons, to sign their names for publication when writing on topics purely mechanical.

In the article in question the statement is made that the pull on the shaft is the same, whether the belt is or is not transmitting power. In other words, the sum of the tensions of the tight and slack sides of the belt is constant under all conditions. This may be true in vertical belts, but where they run horizontally the condition in this respect is changed, for gravity, in most cases of horizontal belts, plays an important part in their efficiency as power transmitters, and the fact that the sum of the tensions is not constant gives the horizontal an advantage over a vertical belt. It is clear that the longer, heavier and tighter a horizontal belt is put on, the nearer constant the tension in the slack side will be, for then gravity is more effective than on a short, longer, loose belt. In the latter case the sum of the tensions may be nearly constant. To me, "this is the long and the short" of this part of the "Principles of Belting."

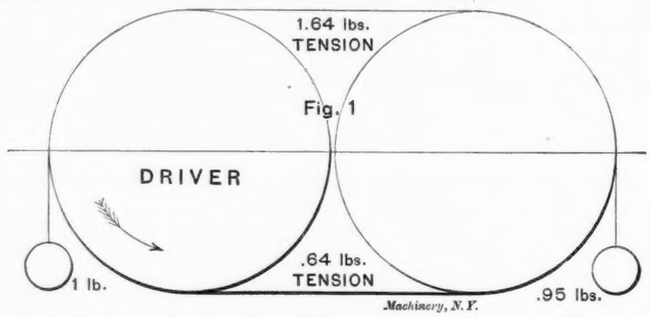


FIG. 1.

The percentage of efficiency of belting is perhaps higher than any other means of transmitting power, but under the most favorable conditions there is some loss of energy due to bending of the belt on the pulleys, the imperceptible slip of the belt on them, and the resistance of the atmosphere. Hence, all other things being equal, when the belt is overloaded, it will slip on the driver in preference to the driven, and this bending will increase as the percentage of efficiency of belt decreases. Assuming the percentage to be 95, a tangential force of 1 pound applied to the driver will be resisted by 95 pounds applied in an opposite direction to the driven pulley, as shown in Fig. 1, in which the pulleys are duplicates, the tension on the tight side, 1.64 pounds, on slack side, .64 pound. In this case the pull on the shaft is the sum of

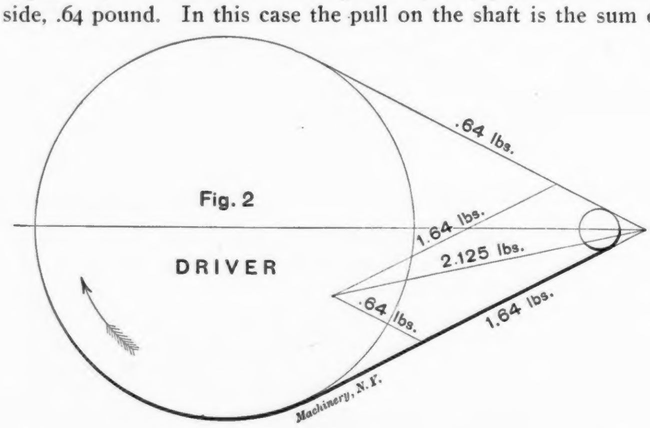


FIG. 2.

the tensions, viz., $1.64 + .64 = 2.28$ pounds. In Fig. 2 only one change has been made, and that by reducing the diameter of the driven pulley to one-tenth its former size. As there is no probability that the driver will slip easier in Fig. 2 than in Fig. 1, the driven in Fig. 2 only will be considered. It is only when belts run with their opposite sides parallel that the sum of the tensions is equal to the contact pressure between belt and pulley. As frictional resistance varies directly as the pressure, it is important that it be known. For this purpose a parallelogram has been plotted on Fig. 2, showing the contact pressure on the driven pulley to be 2.125 pounds, or, say, 93 per cent. of what is on the pulleys in Fig. 1. Hence in Fig. 2 the belt will slip on the driven pulley, and if the same power is to be transmitted as in

Fig. 1, a 2 per cent. wider belt will be required. In cases where the large pulley is the driver, and not more than four or five times larger than the driven, the arc of contact of small pulley will not be considered, for the belt will always slip on the driver if the surfaces of the two pulleys are of the same material and in same condition. In Fig. 2, if the small pulley is the driver, and the belt is to transmit the same power as Fig. 1, it will be necessary to increase the width of the belt 7 per cent. to make the contact pressure 2.28 pounds. In this case the arc of contact is a factor to the extent of 7 per cent. and ought to be considered.

I am led to believe that the author of the "Principles of Belting" has indiscriminately attached too much importance to the arc of contact. I. H. DUNBAR.

Youngstown, O.

* * *

GEOMETRY IN THE SHOP.

RETSEL.

There is no more interesting subject for one who is disposed to study than that of geometry. It literally opens a new world to the student. It gives him his first idea of what it means to really *prove* anything, for the demonstrations of geometry prove absolutely and completely the propositions with which they deal, and he is an exceptional student indeed who cannot derive much pleasure and satisfaction from the way in which each successive step in the proof is brought out and clinched. It must be remembered that it is one thing to absolutely prove a thing and another simply to satisfy oneself that it is so. A person, for example, may, without knowing anything about geometry, satisfy himself that in any triangle the sum of all the angles is 180 degrees. He would probably do this by drawing several triangles of widely varying shapes and measuring the angles, when, upon finding that all footed up to 180 degrees in each case, he would jump at the conclusion that the same fact was true of all triangles. While this would be strong circumstantial evidence, and sufficient, probably, for most cases, it would not be proof that the rule would hold in some triangle not hit upon, nor that he had not made some slight mistake in his measurements.

A good feature of geometry is that it is a practical study. I do not mean to say that the matter found in every page or in every chapter can always be applied to practical work; but, for example, all the rules of mensuration originate with geometry, notwithstanding the fact that they are generally associated with arithmetic, and it is always a source of surprise to find how frequently instances in practical work will arise where the principles of geometry can be applied. Two such have come to my notice and are mentioned herewith.

PLANING A BED PLATE.

A simple proposition in geometry is that two intersecting straight lines lie in the same plane and determine the position of that plane. To illustrate, suppose two straight pieces of wire, *A B* and *C D*, in Fig. 1, represent two straight lines which cross and touch each other at some point, as at *E*. A piece of cardboard representing a plane could then be made to touch both wires at every point in their length, except for the fact that one wire would necessarily be above or to one side of the other by the amount of its own diameter, and the position and slant of the cardboard would be determined by the position of the wires.

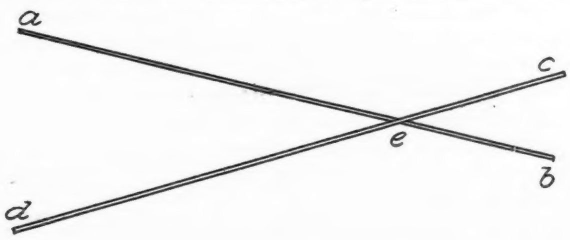


FIG. 1.

This proposition is so simple as to be almost evident, and it is used to advantage many times in shop work, probably without thinking that it has anything to do with geometry, as was the case in planing a certain large bed plate. This bed plate resembled the sketch shown in Fig. 2, and was so large that it would not go between the uprights of the planer. It was desired, however, to plane off the four spots *S, S, S, S*, and it was necessary that they should all lie in the same plane, so that, when the bed plate was set on its foundation all of the spots would be parallel to it, and of a uniform height above it. The bed plate came to the shop, rough on both sides, just as it left the foundry, and was of such size that only two spots could be planed with a reach tool, and it was not practicable to use a bar with one end attached to the planer head and the outer end carried by a temporary support that could be fed along with the head, as is sometimes done. The only possible way of doing the job was to set up the casting twice on the planer table and plane two spots at each setting. It was easy enough, of course, to plane the first two spots, but with a casting weighing several tons and having a rough bottom it was not so easy to set it up right for the second operation. Few shop levels are accurate enough for such work, and it seemed to be necessary to provide at the start a smooth, level bottom for the casting to rest upon.

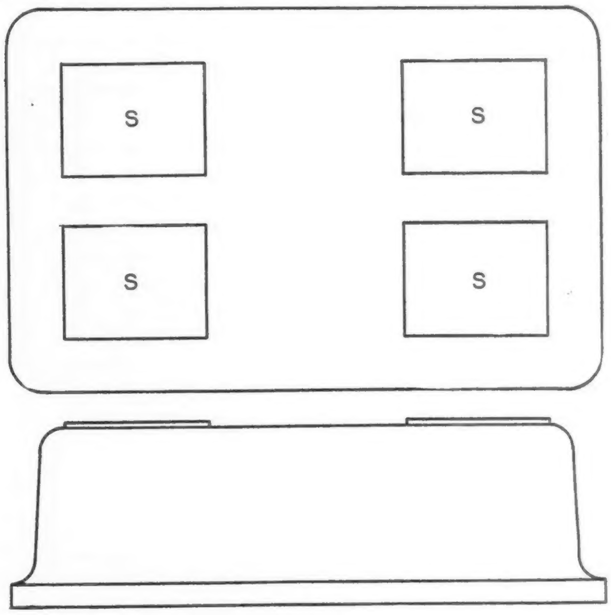


FIG 2

As this could not be done by planing, a makeshift was adopted of drilling four 1-inch holes in the bottom of the casting, as shown in Fig. 3, at *A, B, C, D*, and inserting therein four pieces of cold rolled steel, which were to be filed down, so that when the bed plate was turned over it would rest upon the planer table upon the four pins. The problem then became to work the pins down to such heights that their four ends would lie in the same plane, and thus form an even bearing for the bed plate.

This was easily solved by inserting a fifth pin at *E*, Fig. 3, and filing pins *A, D* and *E* until a straightedge placed in the position of the dotted line from *A* to *D* would touch all three pins. Pins *B* and *C* were similarly treated, until a straightedge extending from *B* to *C* touched the three pins *B, E, C*. When this was done

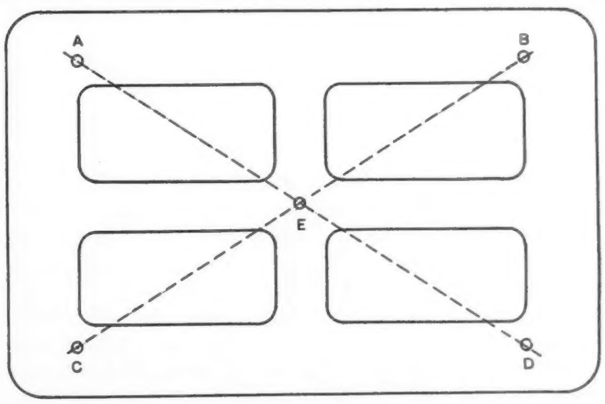


FIG. 3.

it will be seen that the points *A, B, C, D* must have been in the same plane, as was desired, for these points are at the extremities of the two straight lines *A D* and *B C* (formed by the straightedge) intersecting at *E*, and, according to the proposition in geometry, two intersecting straight lines lie in the same plane.

This principle is used by some fitters in testing lathe and planer beds for "wind," and by every machinist when he roughly tests the accuracy of a flat surface with his scale, by putting the scale first one way and then another across the work.

TURNING CONNECTING RODS.

The other lesson came up in the shop when there were some large connecting rods to be turned, and the job was helped along considerably by applying a little descriptive geometry—a branch of geometry that relates quite as much to mechanical drawing as it does to geometry.

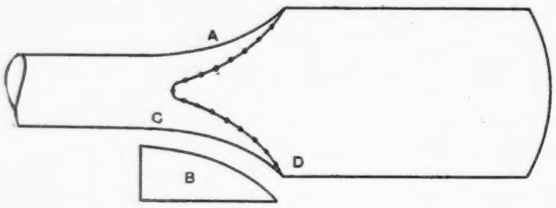


FIG. 4.

The general form of the crank end of the rods before machining was as in Fig. 4, and when the forgings came from the forge shop there was considerable metal to turn off at *A*. Ordinarily this was done by getting the location of points *C* and *D* at the ends of the curve *CD*, turning the rod at these points down to the right diameters and then gradually working down the curved part *CD*, using the templet *B* as a guide. The objection to this method is that the curve shown by the templet *B*, which was made by taking the radius shown on the drawing, is not the curve at the points where the tool starts its cuts, and therefore the method is entirely one of trial, of turning off a little here or a little there, until it comes right. With small rods this way of doing the work answers well enough, but with large rods it is slow. It is a long process to turn them at best, and it would be much more convenient if the curve shown by the prick-punch lines in Fig. 4 were laid out on the face of the rod end. These lines would be where the tool begins and stops its cutting, and the latheman would have something definite to go by. He would be able to take as heavy a cut as the lathe and tool could stand, without fear of spoiling his work. This is what was done in turning the rods above mentioned, and I will show how these lines may be laid out.

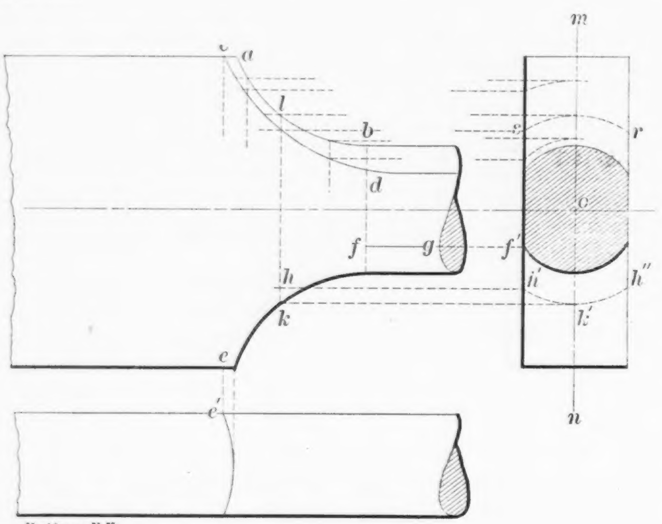


Fig. 5

Fig. 5 shows the front, side and end views of part of the crank end of one of the rods. The curve from *a* to *b* is taken from the drawing, and the problem is to get the curve from *c* to *d*.

For clearness refer to the lower part of the front and end views where there are not so many confusing lines. The point *e'* projected up from below gives point *e* where the curve begins, and point *f'* projected over from the end view, gives point *f* where it ends. Point *f'*, it will be noticed, is where the flattened portion of the rod cuts into the body of the rod proper and the line *f g*, which shows this flattened portion in the left-hand view, will gradually run out as the diameter of the rod becomes smaller, owing to its being turned taper. An intermediate point in the curve lies at *h* and is found as follows:

With *o* as a center, and with any convenient radius, describe the arc *h'*, *h"*. From *k'*, where it intersects the center line *m n*, project over to the left, until the lower curve in the left hand view is intersected, as at *k*. From point *k* draw a vertical line, as shown. Now from *h'*, the point where the arc previously drawn intersects one edge of the rod in the end view, project to the left, until the vertical line just drawn in the left hand view is intersected. This gives *h*, one point in the desired curve, and any other point can be found by the same process. In the upper part of the figure several points of the curve have been plotted and the process can be followed through if wished.

Now as to the reason for this construction. It is very simple and scarcely needs explanation, but, as is often the case, simple things are not always clear at first. Let it be required, as before, to find the location of point *h* in the side view. Suppose the rod to be made of wood, and that we saw it in two along the line *l k*, which we already know passes through the point *h*. After the right-hand portion has been removed, the left-hand portion would, if looked at from the right, appear in the form of *h'*, *h"*, *r*, *s*, in the end view. In this view *h* would lie at *h'*, as must be clearly evident. The lines *h' h"*, and *r s*, however, were the lines that were drawn in the previous construction, so that the process is really that of sawing off sections at different points, and noting where, as looked at from the end, the desired point must come. This is, perhaps, a crude way of explaining the construction, but it is, as far as I know, the simplest way of explaining it where there is no previous knowledge of geometry.

* * *

EXPERIMENTAL WORK AT ROSE POLYTECHNIC INSTITUTE.

We have received from the Rose Polytechnic Institute, Terre Haute, Ind., several illustrated catalogues relating to the various courses and work at this institution, accompanied by a letter from the president, Dr. Mees, who gives a number of interesting particulars about the laboratory equipment and practice. This was one of the first technical schools to organize and put in practice extensive laboratories and shops for instruction in the engineering courses, and the work done in these departments has always been a leading feature.

At this time a number of engineering problems are being studied, several of which, it is believed, will finally settle some questions which have been subjects of contention for some time, and others which suggest new problems because of the rather novel results obtained. The friction of journals in different boxes and the efficiency of lubricants is being systematically studied, a special machine designed by Prof. Gray being used for the purpose.

Another study continued this year is locomotive service upon the L. & N. R. R. These tests are comprehensive, consisting of a complete boiler test, with temperature measurements in the fire and smoke box by the use of electrical resistance thermometers; measurements by integrating indicators of the total work done by the steam in the cylinders in hauling the train over the road in a regular run; the total work done and effort of pulling the train measured by dynamometer car; the study of flange and curve resistances. The complete results will be submitted to the A. S. M. E. The test in its entirety is probably a more complete study of all the elements in the same train which enter such a problem than has ever before been made.

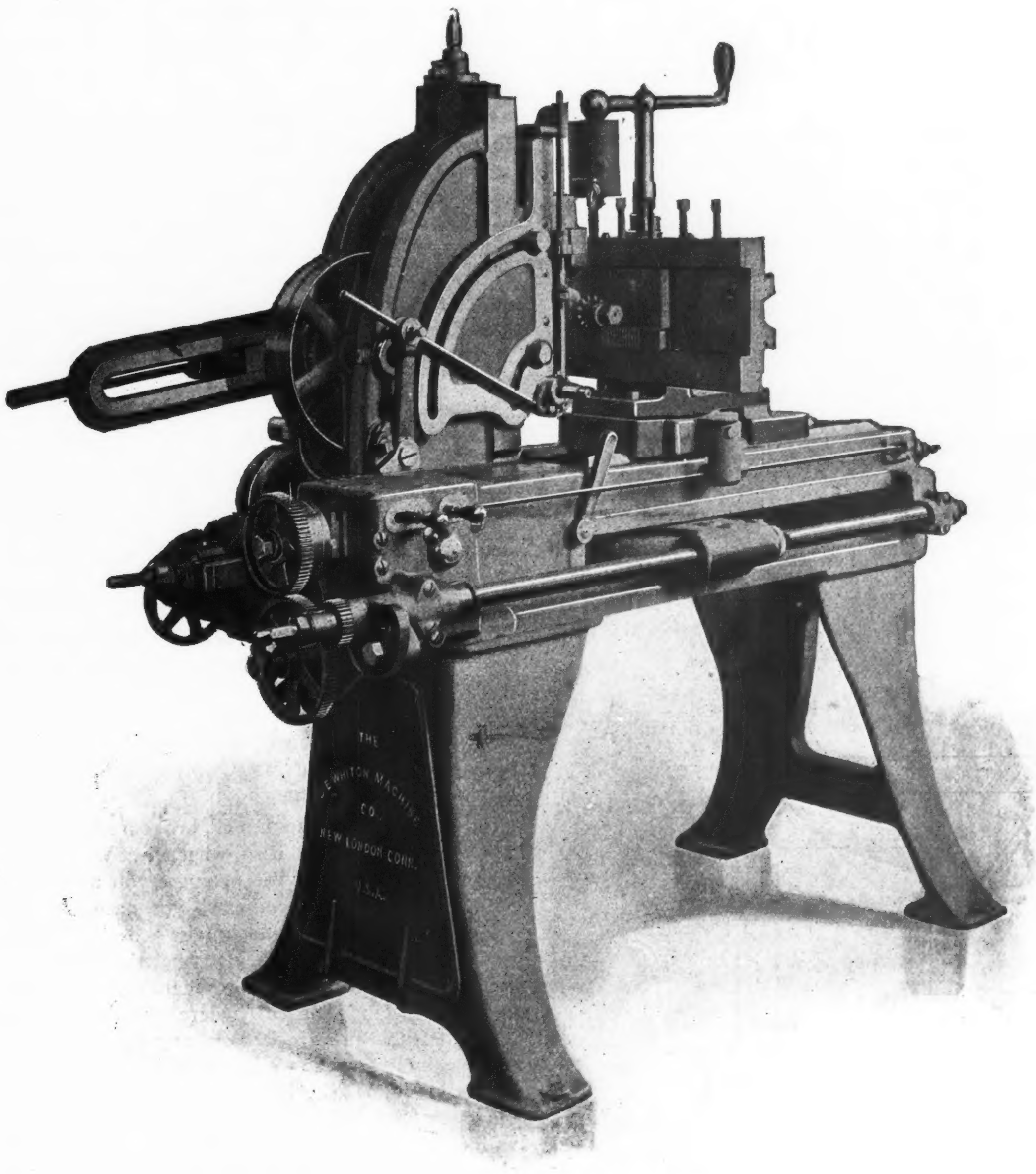
Several other interesting problems in mechanical engineering are being invstigated, and will be reported upon in full in a short time.

In electrical engineering several equally important problems are being attacked and much progress has been made: The study of the breaking-down strength of insulating materials and the laws governing their variation in strength with varying thickness at different temperatures by means of a special transformer giving high voltages is giving interesting results; the use of the electro-dynamometer, of peculiar construction, in place of the telephone in bridge work with alternating currents, the construction of galvanometers of high sensibility undisturbed by external magnetic fields.

In the civil engineering, architectural and chemical departments other valuable work is being conducted in the interests of professional men engaged in these branches and with equally good results.

* * *

A Western dispatch states that an attempt was recently made to blow up a boiler of a threshing engine at Stanford, Ky., by placing a stick of dynamite in one of the boiler flues. For heaven's sake, leave the threshing engine boilers to blow up naturally. They will do it sooner or later, and we cannot imagine a villain so black that he wants to increase the number of fatalities arising from this cause.



HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

1 J. F. P. asks: Can you tell me the exact power lost in starting and stopping the water in the instance of a duplex steam pump of given dimensions? A. No. It is so small as to be of no practical consequence.

2. M. B. H. asks: What is the best kind of packing to use for plunger, valves, etc., of an air pump working against a pressure of from 500 to 1.000 pounds. A. Pack in all respects as if packing against high pressure steam. Of course, you understand that if you use a plunger for a pressure of 1,000 pounds, it must work substantially without clearance, and had better be packed with metallic packing.

3. M. C. H. asks: What will remove the yellow stain from the bright parts of machinery, the stain being due to something in the oil? A. It is generally quite difficult to do this, except by repolishing, if the case is of long standing. You might try a paste made of vaseline, fat and oleic acid, to which is added a little rouge.

4. T. J. R. asks: How can I lay out templates for the hopper shown in sketch, Fig. 1? A. Make an accurate drawing of the hopper to as large a scale as you have conveniences for—full size will be better. The plan will give you all the dimensions you want, except the depth of sheets. This you may find as sufficiently indicated in Fig. 2, in which a is the dimension that is wanting. Transfer the measurements to the template, allowing for lap. Sheet b presents a little difficulty owing to the circular corner, but this is easily come at by calculating, or by measuring in any way, the length of the front of the circumference of the circle embraced in the rounded point, the addition to the sheet being wedge shaped. By a little pains in making the drawing, you will have no difficulty. If you have doubts in the matter, cut some paper templates to scale, and by bending them to shape you can easily satisfy yourself.

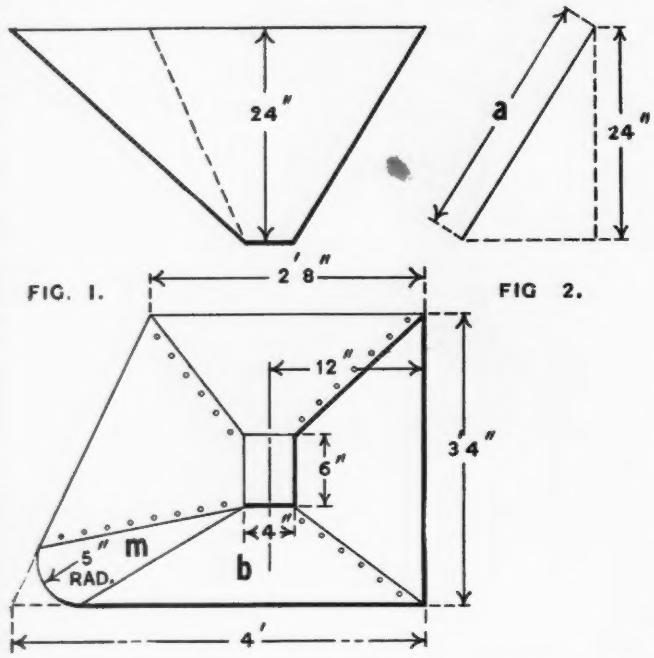


FIG. 1. FIG 2.

5. W. F. R. (England) asks the following questions about pickling brass castings, saying that he anticipates having from 3½ to 4 tons per week to pickle: What are the ingredients of and pickle and preparation of same? How soon does it depreciate and require strengthening, or is it thrown away when it becomes weak? Is the solution poured over the articles or are they immersed? If articles are placed in the solution, how long are they kept there? How are they washed, and is hot or cold water used? Of what material is tank made, and how is the tank arranged? How can it be told if pieces are pickled enough? A. Brass castings are cleaned in different ways, according to the purpose in view and different opinions. When a fine color is desired, 2 parts water, 2 parts sulphuric acid and 1 part nitric acid may be used. First mix the water and sulphuric acid. The chemical combination will heat the mixture. When cool, add the nitric acid. When cool again it is ready for use. The solution may be kept in a wooden box or trough that is lined with heavy sheet lead. Into this the pieces, previously brushed with a stiff wire brush, are dipped and quickly withdrawn. If it seems necessary, this dipping may be repeated. Then rinse, first in cold then in hot water. Or the solution may be water 100 parts, oil of vitriol 100 parts, nitric acid 50 parts and hydrocloric acid 2 parts. Then rinse in cold water, then hot, as before. Perhaps in either instance rinsing in cold water will be thought sufficient. When nothing is cared for color, a weak solution of muriatic acid and water may do the work satisfactorily. Experiment in a small way until the strength is found to be right, beginning, say, with 10 parts water to 1 of acid. The solution will not require strengthening; it is likely to grow stronger by evaporation of the water. All the renewing it requires is adding to from time to time, as it disappears. You can use this pickle as you would pickle cast iron, having a shallow lead line tank for the solution and an inclined platform to lay the castings on, pouring the solution over them from a ladle and letting it drain off into the tank. Determine the length of time you keep wet with the solution by the results. Rinse off with cold water in the way most convenient.

6. J. D. writes: I am employed in a wood-working establishment, working on the second floor of the building. In very dry weather the machines become so charged with electricity as to cause a good deal of annoyance. What is the cause, and is there a remedy? A. The machines standing on the dry floor are insulated very completely, and are charged with electricity from the belts, the result of friction. We have heard of this remedy being applied: Drive wires into the floor and wire to each machine and to the water pipes. This permits the electricity to pass away quietly instead of accumulating. We believe, but are not quite certain, that Mr. C. M. Conradson, of Madison, Wis., first proposed this plan.

7. R. C. asks: Can I melt broken steel castings along with iron in my cupola, and if so, what effect will the steel have on the castings I make? A. We presume you mean to ask if you can melt what steel scrap comes to you naturally with advantage—or, at least, without disadvantage—to your castings. This has frequently been done, but just what the effect is on the castings we think is hardly settled. We have seen castings made that were not to be finished, where considerable scrap steel was charged with the iron, without any apparent injury to the castings, which, so far as we know, is the best that can be said of it. Sometimes steel with only a small percentage of iron is melted, in which case it is, sometimes, at least, the practice to charge with iron first, following with the mixture. When the iron charges are out, the steel will soon come down. By experimenting a little, you will probably have no trouble, but we think the most you will gain will be the using up of scrap otherwise useless.

8. J. S. H. writes: Will you kindly tell me how I can find the length of time it will take my lathe carriage to run any given distance? The screw of the lathe is 2 to 1 inch, and the gears are 24 on spindle and 54 on screw. There is a pin which gives me three ranges of feed by moving in and out. I would like to know a rule whereby I can figure on any kind of lathe, if there is such a rule; if not, give me best you have. A. You do not give sufficient data to enable satisfactory figures to be given. However, this is scarcely necessary, as you have everything at hand for the purpose of calculation. All you have to do is to find, by counting, how many revolutions of the spindle will move the carriage a definite distance, as 1 inch, then count the number of revolutions the spindle makes per minute and the rest is a simple sum in arithmetic. Since we know nothing of the definite effect of moving the "pin" in and out, we can hardly help you further than this. Assuming the pin to be inoperative and the

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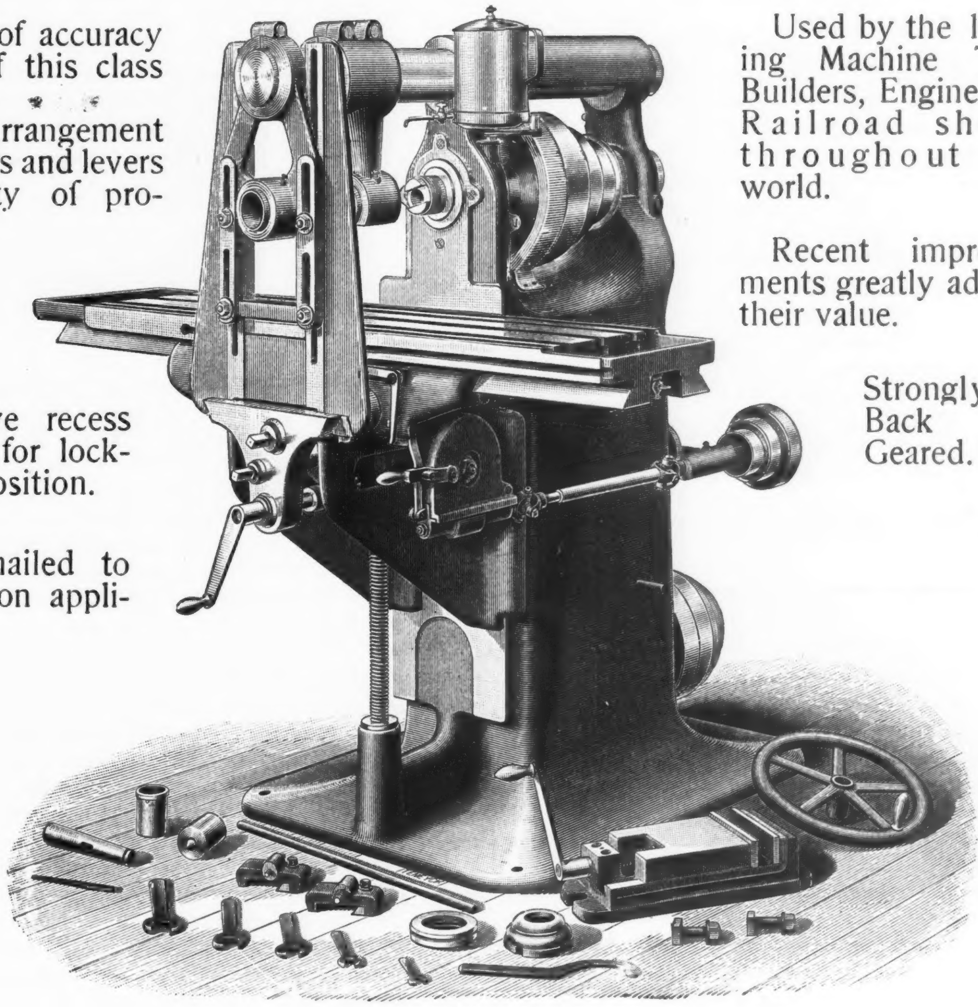

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spindle to be making twenty revolutions per minute, then the carriage (the screw advancing it $\frac{1}{2}$ inch each revolution it makes) would advance $(20 \times 24/54) \times \frac{1}{2} = 4.44$ inches per minute. As was said before, we do not know in what ratio the pin modifies this, and therefore advise that you come at it in the way first indicated.

9. L. H. R. writes: I am an apprentice serving my last year, and am put on a planer. The shop is a fairly good one, but has not the facilities of some of the larger shops, so we have to plan ways ourselves for doing many jobs that come along. There are two jobs that frequently bother me. 1. I have strips to plane all over $\frac{3}{8}$ inch thick, $1\frac{3}{8}$ inches wide, and from 6 inches to 13 inches long. These strips must be very true, and I fail sometimes in getting them exactly so, owing to their lifting a little in the chuck or something of that sort. Can you suggest a way

FIG. 3.

of doing this? A. Get out two taper pieces, Fig. 3, a trifle narrower than the pieces you have to plane. These pieces should be planed very accurately, taking the last cut over one of them with the two wedged together in the chuck. The accuracy with which you can plane the strips will depend upon the accuracy with which you plane these pieces. Lay the pieces together in the chuck, about as shown in the sketch, and the strip to be planed to finish top of them. Screw up lightly on the chuck screws, and lightly drive one of the pieces. Continue this till the strip is tight enough. You can scarcely fail in getting them true in this way. Several pieces like these shown, planed in pairs and of different dimensions, are extremely convenient for planer work. 2. I sometimes have irregular pieces to plane, scarcely more than $\frac{1}{8}$ inch thick, some of them being as much as 8 inches long and $4\frac{1}{2}$ inches wide, the outline being irregular. We have no way of holding these pieces so as to plane them to an even

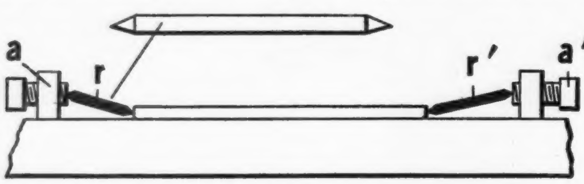

FIG. 4.

thickness, and a good deal of filing must be done on them. In what way can I hold them so as to plane them fairly true? A. For planing one of the surfaces lay the piece down on three small pieces of wood, level it up, build a dam of clay or putty around it and pour plaster of paris for a bed. Plane the surface, turn over and lay on the table and plane the other surface. For holding down both to the plaster bed and the table, adopt the plan indicated in Fig. 4, in which sketch a a' are planer stakes tapped for small screws; r r are small steel rods pointed at each end. One of the pointed ends is in a small center punch mark on one end of the strip to be planed, and the other in the center of a screw. Tightening the screws will draw the piece down to the table, and it can be staked to prevent moving. By the exercise of a little care, screwing up lightly, you can get as fine a job as you like. The cut must, of course, be light, and the feed fine.

10. T. L. J. writes: I have constant trouble with the packing around the valve rod of my engine. The stuffing box is deep, but the rock arm is very short for the travel of the valve, which

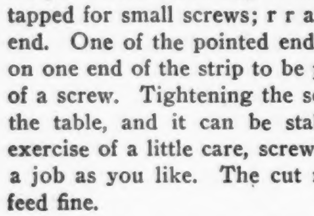

FIG. 5.

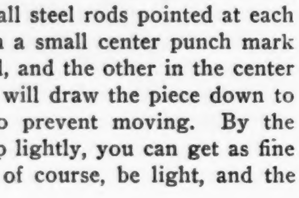

FIG. 6.

is 5 inches. This raises and lowers the rod so much that the packing requires attention at least twice a day. I have tried packing with hemp and with prepared packing, but neither will stay tight for any length of time. Can you suggest anything better for the purpose? A. The trouble is, of course, with the oscillating valve rod, and the remedy is to make the connection from the eccentric in such a way as to avoid this, or at least to modify it by using a longer rock arm. It is doubtful if you can find anything much better in the way of packing than some of the prepared kinds, something with a rubber center, for instance. You might try packing, as indicated in Fig. 5, in which pieces *a* are cut from pure rubber and spaces *b* are packed with hemp alternately. Or you might cut from a sheet of pure rubber two strips, *s s*, Fig. 6, the thickness being a little less than the packing space in the stuffing box. The length of these pieces should be such that they will lap around the rod, and they should be placed to "break joints." Front of these is a braided hemp gasket, *g*, calked in. Another plan is to cut a strip of rubber, *r*, Fig. 7, insert it lapped around inside the box and pack the space inside the rubber and beyond it with hemp. Still another plan is to cut a long strip of rubber that will not quite fill the packing space, and wind it about with hemp. The chief utility of the rubber in either case is to form an elastic cushion that will yield to the sway of the rod and recover itself to prevent leak.

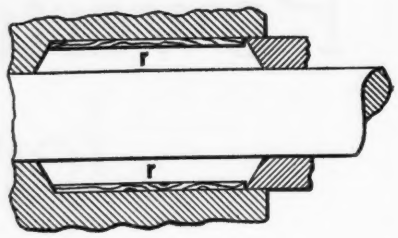

FIG 7.

11. J. W. writes: I am told that a suction pump will lift water higher if it is set just at the level of the ocean than if it is set higher, as on a high hill, but I do not see quite why this is so, or how any calculations are made in regard to it. It seems to me that the suction will be just as great with the pump in one place as another. Can you make this plainer to me? A. Throw aside the altogether confusing and unnecessary word suction, and you will have no difficulty in understanding the matter. Water is *forced* up the pipe to the pump by the pressure of the atmosphere, which decreases as we go above the level of the sea. The pump first removes the air—some of it—from the top of the water, and the greater pressure of the atmosphere, which pressure acts in all directions, forces the water up the pipe just as it forces the mercury up the tube of the barometer (there being no air in the tube above the mercury). When it is said that the pressure of the atmosphere is greater at the sea level, it is equivalent to saying that a cubic foot of air taken from that level will weigh more than a cubic foot taken from a higher level. The pressure of the atmosphere varies from time to time, no matter what the level may be, its pressure being conveniently indicated by the height it will support a column of mercury. A cubic foot of water at a temperature of 60 degrees weighs 62.367 pounds, and a cubic foot of mercury at the same temperature weighs 846 pounds. Mercury is therefore $846 \div 62.367 = 13.56$ times heavier than water. Consequently the pressure of the atmosphere at any position in reference to the sea level will force water up a tube or pipe 13.56 times farther than it will mercury. Hence, if the mercury at the sea level stands at 30 inches, water would be forced up a pipe from which the air was entirely exhausted $30 \times 13.56 = 406.8$ inches — 33.9 feet. If we place the pump at such a height above the sea level that the mercury stands at only 20 inches, then the atmosphere will force water up a pipe no more than $20 \times 13.56 = 271.2$ inches — 22.58 feet. To find, then, to what height water will be forced up a pipe in which there is absolutely no air, multiply the inches of mercury shown by the barometer by 13.56. It is needless to say that all the air cannot be pumped from a pipe, hence water will not rise in it to quite the height indicated above.

12. E. M. asks: Will a bar of iron 2 or 4 inches square, if heated to a red heat, expand less in length than a test bar 1 inch square similarly heated? An old blacksmith here says it will. A. The expansion will be the same in each instance. We have known blacksmiths to have the same opinion, but always believed that when they made their observations the larger bar was comparatively cool at and towards the center, and that this cool part restrained the expansion of the shell that was heated.

12. R.A.B. writes: I have a feed pump operated from the crank shaft of engine. The pump takes water from a small tank into which I regulate the flow of water, so as to just supply the boiler. The pump, working as it does—it is a plunger pump—must pump considerable air. Will this do any harm? A. It will do no harm and probably no good. We believe that there was, at one time, a patent on an arrangement for using a combination of air and steam for operating engines, but we never heard of any good from it. Some believe that pumping some air into the boiler something as you speak of, promotes circulation of the water, which may be true to some extent, but probably not noticeably. If you had means of observing very carefully you would probably find that you did not get full returns for the power consumed in handling the air, but as you use but little the loss would be trifling.

13. J. E. M. writes: I have to keep in operation a pump pumping hot water. The water ports are very crooked and are so filled with lime scale that the pump will scarcely force water through them. Owing to the ports being so crooked this scale cannot be reached to chip off. Can you suggest any way of removing it? A. It is sometimes troublesome to get rid of this lime scale when it cannot be reached with a chisel. Probably by plugging the lower ends of the ports and filling them with kerosene oil, letting it stand over night and as much longer as you can, you may get rid of the scale. This, if repeated once or twice, will loosen it so that it can be worked off with a small iron rod that will accommodate itself to the crooks in the ports. It is advisable to get rid of the scale even at considerable trouble. It is evidently costing considerable coal to force water through the obstructed ports, and the pump is liable to break down from the rough usage.

14. L. B. M. asks: (1) What is the rule for the horse-power of shafts of given diameters? A. Shafts are, very commonly, divided into three classes, viz., (1) the shaft which first receives power from the motor—the jack shaft—which is sometimes a separate shaft and sometimes an enlarged section of the line shaft; (2) the line shaft, and (3) short shafts—countershafts. For these formulas as follows may be used:

$$\text{For 1, H.-P.} = \frac{D^3 \times R}{125};$$

$$\text{For 2, H.-P.} = \frac{D^3 \times R}{90};$$

$$\text{For 3, H.-P.} = \frac{D^3 \times R}{50}.$$

In these expressions $D =$ nominal diameter of shaft—its diameter before it is turned, and $R =$ the number of revolutions per minute. Putting the first of these formulas in the form of a rule it would read: Multiply the cube of the nominal diameter of shaft in inches by the number of revolutions per minute, and divide the product by 125; the quotient will be the horse-power (H.-P.) of the shaft. The other formulas are explained in a similar manner. For an example, take the first case cited, that of a jack shaft: What is the horse-power of a jack shaft 4 inches nominal diameter, making 200 revolutions per minute? The cube of 4 is 64, and 64 multiplied by 200 and divided by 125 = 102+, the horse-power of the shaft. (2) What distance apart should the bearings be? A. Common practice is from 8 to 12 feet centers, depending somewhat upon how heavily the shaft is to be loaded. (3) How much stronger is cold rolled than turned shafting? A. We believe it is rated as being nearly or quite 50 per cent. stronger.

15. R. E. B. writes: I have a short line of track—less than one-half mile—over which I transport logs on platform cars, using a small locomotive. The logs are taken from the river to the steam mill, the grade being rather steep. The track is in as good condition as on any railroad. I want to take three cars of logs from the river up to the mill, and my engine is a little small to do the work comfortably. The wheels under the cars are 24 inches in diameter. My superintendent claims that if we use cars with 36 inch wheels the engine will be large enough, as the cars will run very much easier. Is he right, and if so, how can I determine how much less power will be required to move the three cars at a given speed when the large wheels are used than when the small ones are under the cars? A. Your superintendent is probably right in concluding that less power will be required to pull the cars provided with the 36-inch wheels, but if the track is in the condition you say it is, there will be but little difference as between the large and small wheels. This difference has, as between 33 inch and 42 inch wheels, been found to be as little as 1 per cent. on a good track, and as high as 5 per cent. on a track not in so good condition. It is not easy of clear demonstration why this difference exists, and the matter is not well enough understood to enable you to make any definite calculation as to the probable gain from the use of large wheels. The journal friction would be a little greater in the instance of the small wheels, but the increased effort required to mount an obstruction, as presented by the unevenness of track, multiplied by the duration of the effort, will be nearly the same for each size wheel. We can conceive that an imperfect track—and all tracks are more or less imperfect—will disturb the steadiness of the cars more when on small then when on large wheels, but to what extent this would increase the power required to run a train of cars cannot be calculated, because there are no available data to work from. In a general way it may be said that the advantages of large truck wheels, considered from the point of the power required to move the train, has been a good deal overestimated.

16 J. L. writes: I am running an automatic cut-off engine, cylinder 18 inches x 36 inches, revolutions 85. The steam pipe is 4 inches in diameter, 35 feet in length, and has two elbows in its length. The throttle is a ported slide, the area of the ports being 9½ square inches. The indicator diagram shows a good deal of falling off in pressure as between the boiler and cylinder. This I claim is due to the restricted passage through the throttle valve. I claim that a larger steam pipe with the same throttle valve would not help matters any. Am I not right? A. In all probability, no. The probability is that the low pressure in the cylinder is due to the small steam pipe. For a steam pipe the length you give, with two right angles, and the piston speed being more than 500 feet the diameter should not be less than 5 inches. While we should not use a throttle valve having a less area of opening than the area of the steam pipe, one somewhat smaller would probably do as well. With the indicator mounted on the steam chest, we have tried the effect of gradually closing the throttle without any effect on the diagram until the throttle was more than half closed. This when the steam pipe was too small. The reason is that the stricture caused by the small opening through the throttle is short in length, and hence causes but little friction, while the friction in the pipe is along its whole length. You can readily ascertain if your small throttle reduces the pressure in the cylinder by mounting your indicator on the steam chest, taking a diagram with the throttle wide open, then close the throttle a little and take another. If you find, as we think you will, that you can close the throttle to quite an appreciable extent without affecting the steam chest diagram, the conclusion will be that there is no trouble at the throttle. The trouble is then with the steam pipe or with the steam ports. If the area of one of the steam ports is as much as 1-11 (it should be 1-10) the area of the piston it is pretty certain that the fall in pressure is due to the small steam pipe. In any event your steam pipe is too small.

* * *

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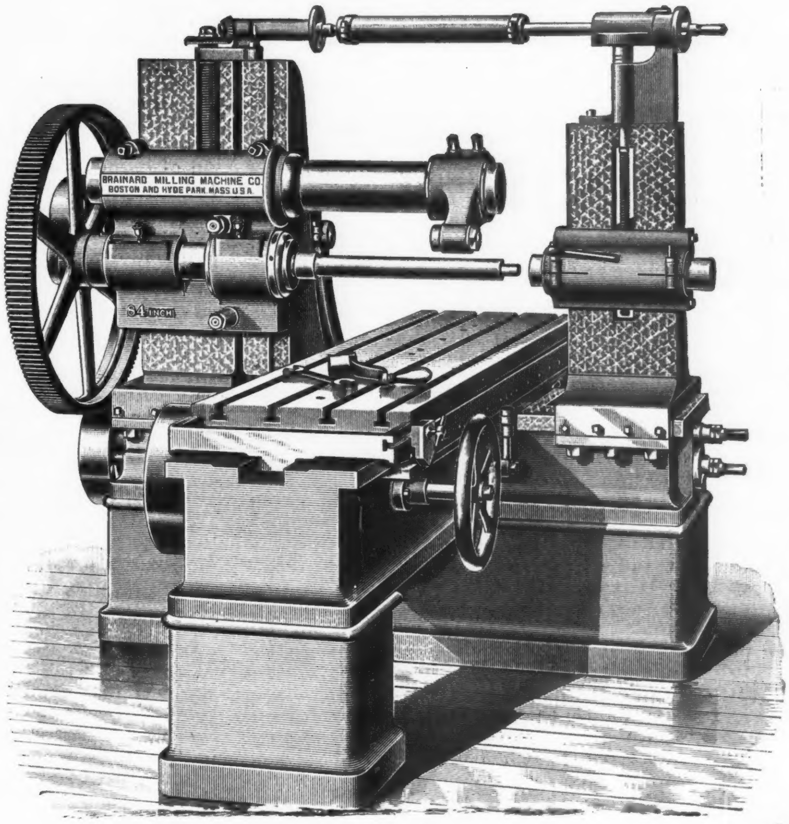

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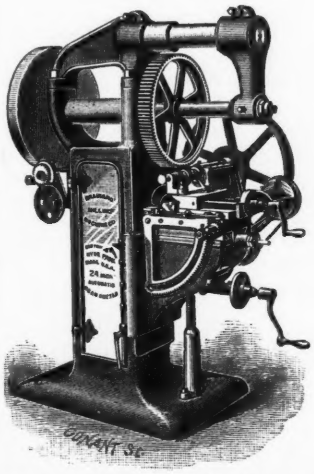

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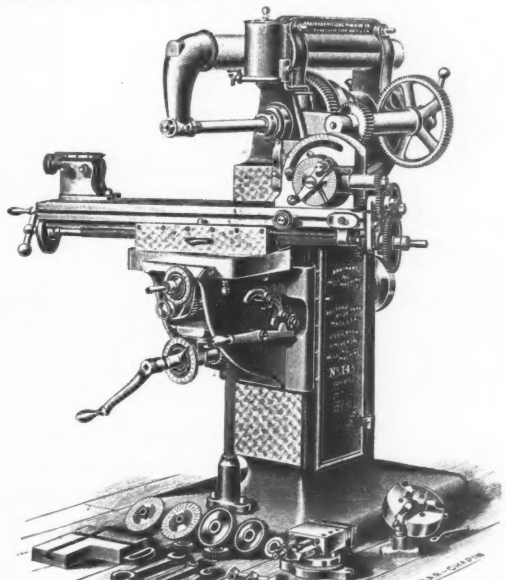

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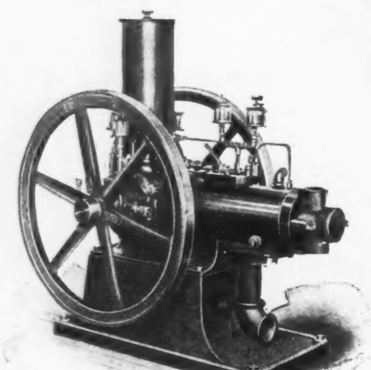
carries a saw 60 inches in diameter, and is adjustable both vertically and horizontally, and will cover a range of work within a square or parallelogram of 8 feet in height and 20 feet long, allowing a steel casting to be clamped to the bed plate and the entire series of heads cut off within this range without moving the work. Among other large tools that they have recently completed is a slab milling machine for the General Electric Co., having a range to admit work 72 x 72 inches, and weighing about 50,000 pounds.

THE SPRINGFIELD MACHINE TOOL CO., Springfield, O., have just erected a fine foundry, 60 x 175, with two wings, which they are now equipping with all the modern appliances, and which will enable them to make some changes in their plant which will relieve its present overcrowded condition, and add to their facilities for the manufacture of machine tools. The business of this company for the past twelve months shows an increase of about 40 per cent. over that for the previous year, and about 90 per cent. of their business is foreign. Mr. Montanus showed the writer a file of unfilled orders which he was pushing through as rapidly as possible, and hopes with his increased facilities to catch up with the foreign trade at least.

Nearly all the machine tool builders in Cincinnati either have built new shops or are intending to do so. The Cincinnati Milling Machine Co. have completed a large addition to their works, while not far from them Dietz, Schumacher & Boye are getting settled in their new shop. The Lodge & Shipley Machine Tool Co. have just purchased a lot on Coleraine avenue, near Hopple street, where they are about to commence the erection of a large shop, of steel and brick, 90 x 300 feet long, having two stories in the front, with accommodations for the office, and one story running back the entire length of the works. Above the works will be a clerestory, 8 feet high, to afford not only light but ventilation, supported by columns, so that the width of the shop will be divided into three sections of 33 feet each, the middle section giving a clear run for cranes, etc. The G. A. Gray Co.'s new shop has been completed some weeks and ready for occupancy, but up to recently they were unable to stop work long enough to move. Rahn & Mayer, Gang and a number of other smaller shops are looking about for increased facilities.

MIETZ & WEISS KEROSENE ENGINE.

The kerosene engine illustrated herewith is manufactured by August Mietz, 128 to 138 Mott street and 87 Elizabeth street, New York, in sizes from 1 to 10 HP. It is intended to provide a safe and reliable power, and has the advantage that it does not depend upon a gas supply, nor is there the danger attending its use that is present with gasolene motors. The cut shown conveys a fair idea of the general design. A closed oil tank of a capacity of ten hours' run is screwed to the engine cylinder above the crank chamber. From this tank the kerosene is forced into the cylinder in liquid form through a small copper tube, and there vaporized and mixed with the proper quantity of air to produce perfect combustion. To maintain a uniform speed the engine is governed by regulating the number of impulses. At full power an impulse is received at each turn of the crank; that is, the air and oil injection, the compression and burning of the mixture, and expulsion of the exhaust are all performed in a single turn. The consumption of kerosene is proportioned to the actual power developed by the engine. With kerosene costing eight cents a gallon, it is stated by the manufacturers that the cost per horse power per hour is about ¾ of a cent.



FRESH FROM THE PRESS.

A POCKET BOOK FOR MECHANICAL ENGINEERS. By David Allen Low, Whitworth Scholar and Professor of Engineering, London Technical College. Longmans, Green & Co., New York. 740 pages, illustrated.

We have found Mr. Low's published works in geometry and machine design to be excellent treatises, and upon receipt of this one, therefore, we were naturally predisposed in its favor; and such brief attention as we have been able to give to it has not changed our opinion in this respect. Compared with Kent's pocket book, recently published in this country, it does not contain nearly as much matter, nor does it cover the ground for an all-around mechanical engineer's pocket book so completely. At the same time it has certain features of its own that make it a book of great value. It is particularly a book for designers, the subjects treated bearing largely upon mechanics and machine design. There are the usual tables and notes relating to mathematics and materials, and the treatment of the different parts of mechanics, including hydraulics, is clear and complete. The strength of materials and the proportions of machine parts, including framed structures and boilers, are given careful attention. About fifty pages are devoted to the locomotive, and there are notes upon compressed air, gas engines and various other mechanical subjects. In the preface it is stated that all the tables have been carefully checked, and that where tables have been taken from other works the same care has been used to eliminate all errors. The work has been in preparation for the past five years. It is illustrated with numerous original drawings, many of which refer to the proportions of machine parts.

EASY LESSONS IN MECHANICAL DRAWING AND MACHINE DESIGN: ARRANGED FOR SELF INSTRUCTION. By J. G. A. Meyer. Published by the Arnold Publishing House, 16 Thomas street, New York.

This work has had favorable notice from time to time in these columns, as the various sections in which it is issued have appeared. The entire work is to consist of two volumes, issued in twenty-four parts, which are sold for 50 cents each, and we have recently received the last of the first twelve parts, which make the first volume.

The course of study comprised in these lessons is arranged in three divisions, consisting of geometry applied to mechanical drawing, practical rules and useful data, and practical exercises in machine design. Under these three headings is intended to be given the kind of information that one ought to have who is engaged in machine construction, whether in the shop or drawing room. The first twelve parts are illustrated by nearly 500 engravings and thirty full-page plates, all of which are exact reproductions of the author's work. It is one of the most complete as well as valuable works that we are acquainted with.

THE LOCOMOTIVE LINK MOTION. By Frederick A. Halsey. Press of Locomotive Engineering, 256 Broadway, New York. 81 8vo pages, illustrated. Price, $1.00.

This work is composed mainly of articles that Mr. Halsey has contributed to the "American Machinist," with a chapter upon the plain slide valve, taken from the author's "Slide Valve Gears," published by the D. Van Nostrand Co.

It is safe to say that it is the most important work upon the Stephenson link motion that has appeared since the publication of Auchincloss' "Slide Valve and Link Motion." It is important because the matter presented is new and contains some new facts about the link motion. Most of the books that have been written in recent years, treating of the link motion, have been composed largely from matter originated by older investigators and contained in such works as those of Auchincloss and Zeuner. In this work, however, the whole subject has been carefully investigated anew, and the author was fortunate in having at his disposal the data that has been gathered by the Schenectady Locomotive Works during their long experience with the link motion. The information upon laying out the link motion and valve setting, therefore, accords with the latest practice, and in this respect differs materially from anything that has previously appeared.

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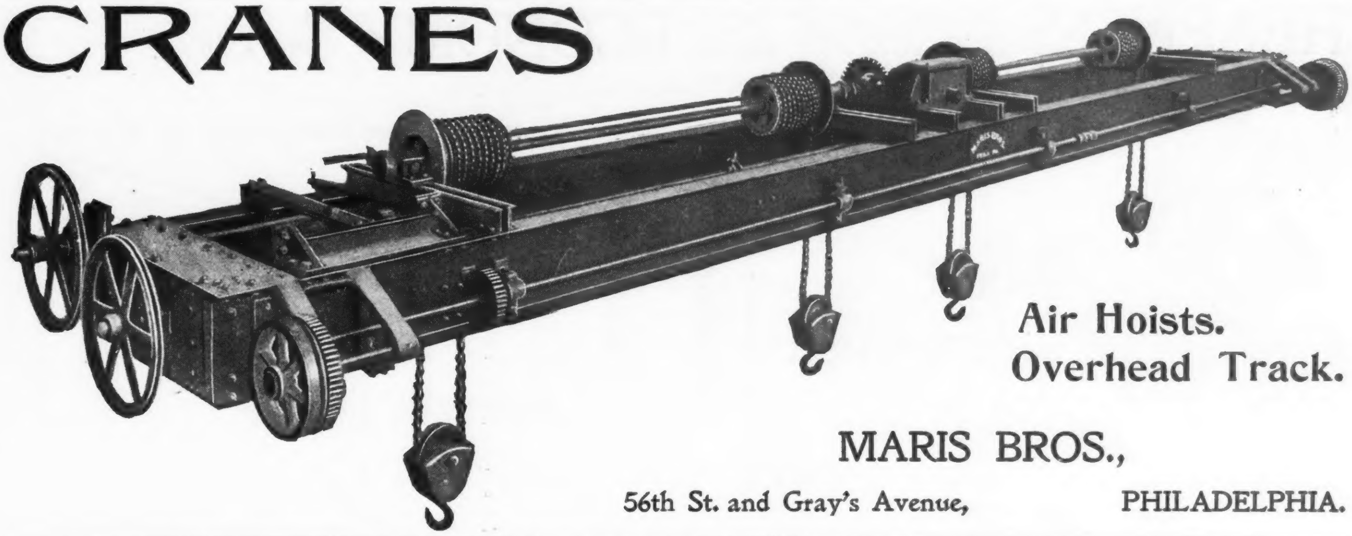

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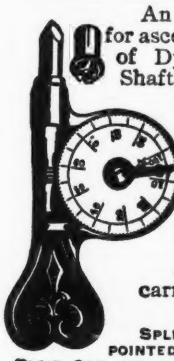

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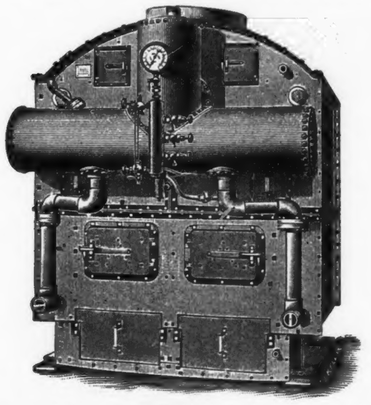

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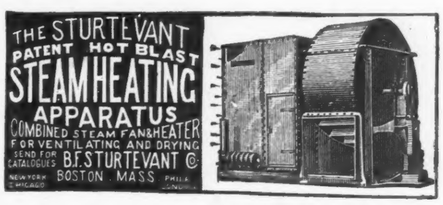

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